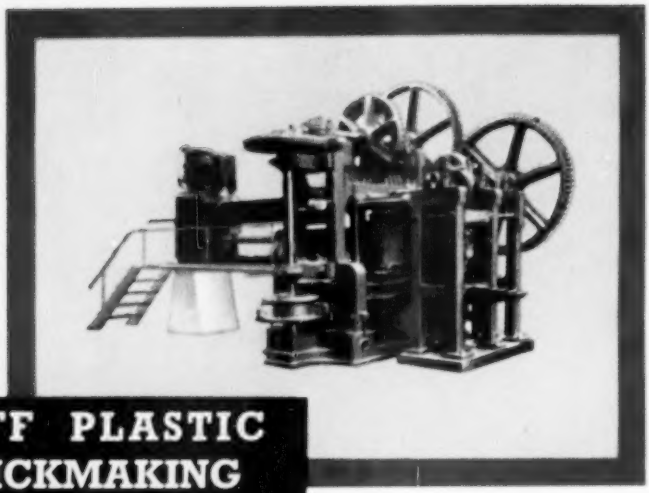
CERAMICS



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Ceramics

VOL. II JUNE, 1950 NO. 16

Decorated Ware

LIFE becomes befuddled with inconsistencies when outside bodies attempt to control and direct business.

Featured in this issue is an article on Decorating Ceramic Ware—whilst coincidently the Board of Trade is busily engaged in one of its largest prosecutions for its alleged illegal disposal!

The Board itself points out how troublesome it is to track down this illicit pottery—and one can imagine the expense in man-power and cash spent in snooping out the necessary information for the prosecution.

Obviously there are folk in Britain who are willing and anxious to buy it. One gathers the Government's friends—the Co-operative Societies—are anxious to obtain it. The Pottery Manufacturers' Federation tries to get some relaxation, for it appears that the attitude of the Board of Trade officials towards the manufacturer is one of intense suspicion until innocence can be proved! It is like the old red petrol—a garage fills you up with red and the onus was upon you to prove your innocence.

This refutation of the British legal assumption that a man is innocent till he is proved guilty is tantamount to dictatorship and is unconstitutional in spirit if not in reality.

There is no regulation or control which the Government has introduced which they have been able to enforce without converting the great British public into a mass of petty criminals. For once no one can admit in public that they have never broken the law.

The pottery industry is doing about eight million odd pounds export trade, and half of it to the dollar areas. The pottery manufacturers have played the game as dollar earners, and now when they ask for a relaxation in distribution of decorated ware to the home market they have earned the right of a hearing.

Their demands are not unreasonable—and their reasons demand consideration.

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Technological Education

The Background and a Suggestion for the Future

• *by Argus* •

THE obvious importance of this aspect of British education has become prominent in recent months. Those of us who have the opportunity of discussing the subject with executives in a variety of industries realise only too well that British industry is suffering badly from the recruitment of wrongly trained personnel.

Unfortunately the problem is highly complicated because of the manner in which British popular education has evolved. As far as the great mass of people are concerned we have only had about two or three generations of free popular education. In so far as advanced education beyond the age of 14 and 15 years; here the charity and patronage background which initiated most of our well-known educational institutions lingers on. The foreigner views our educational system as being one of the craziest schemes in the world although of course to combat that accusation we are prone to point out that in spite of it, in the fields of science, literature and the arts we have at least held our own. But we tend to forget that the heyday of British industrial development was reached at a period when other nations had not developed their industries and many of our much vaunted achievements result from this initial impetus.

End of British Supremacy

Today however, it would be a man of extreme temerity who would boast the technical advancement in Britain as being well ahead of the continental nations or America. There is no doubt that our rapid development did result in a tendency for us to rest on our laurels. And it was during this resting period that the nations of the Continent and the New World were struggling to achieve industrialisation. The year 1918 saw the end of so-called British technical supremacy by worldly comparison.

Training in Europe

The growing industrial nations of Europe realised that the ousting of British manufactured goods from established world markets could only take place by a concerted effort. With Teutonic thoroughness they began at the lower end of the scale namely training their youth. Their educational system was built up diametrically opposite to the liberal approach in Britain. For example the universities of Oxford and Cambridge only introduced science into their curriculum when the newer provincial universities compelled them to do so. There was then, and to some extent there prevails today, a tendency for the student of the Arts or Classics to consider the student of pure Science as being on a somewhat lower intellectual and moral plane. In turn the pure Science graduate tends to look down with disdain upon the graduate who has obtained a degree in engineering, textiles, glass technology or even chemical engineering.

The background of our liberal traditions in education is reflected in the science departments of our universities which are, in general highly academic and offer practical instruction as a relatively unimportant part of the student's training.

For many years now the universities of Britain have been almost the sole resource for recruitment of technicians to industry, whilst the newer technical colleges are looked down

upon in social status by comparison with the universities.

In fact, if one could level the greatest criticism of the British educational system it is that it encourages this snob value in terms not only of the institution where the education is implemented but even the very subjects which the student selects for study. In spite of a vast state machinery for primary education we still permit a very large number of tiny inefficient private and preparatory schools to exist and the pupil at the latter again looks down upon the pupil at the former. When it comes to secondary education, again we have vast resources of state secondary schools. Catering for the same age group we have public schools which are in reality private schools, some grammar schools which operate partly under the State ægis and partly by charity foundations and we have technical schools whose students are looked upon as being little better than the elementary school but not quite so good as the secondary school in terms of social status. And this snob value is reflected in the teaching staff itself—they belong to different Unions!

It is in this quite obvious chaotic educational background that we seek the raw material for industry.

Better Technical Education

The universities are agitating that they should be entrusted with the technological education of the young Britons. The technical colleges are agitating to be given the status of universities. But in all this one sees that the primary motive for change—namely better technical education—is being overlooked in the interests of the educational institutions themselves. The staff of the technical colleges are desirous of achieving the social standing and remuneration of the university. The university on the other hand tries to hold on to its privileged position as the highest dispenser of knowledge for as long as possible. The greatest difficulty concerning technical education is not whether it is conducted in the technical colleges or in the universities but rather by whom it is to be conducted. As far as professional teachers are concerned we are dependant upon the graduates who were turned out by the universities. Their very training has closed their minds to the realities of commerce, business and industry. Their educational and cultural circle was the secondary, grammar or public school to the university and back again to staff the same institutions. By far the largest proportion of our science teachers in the universities, secondary schools and technical colleges have had no contact whatsoever with the applied science of commercial development and manufacture. The professional teachers of science after a few years become stereotyped. They teach the same syllabus year in and year out in physics and chemistry. The experiments with magnets and iron filings have become traditional. Quantitative analysis in the test tube is still the most important practical instruction of the chemistry student.

It would appear therefore that neither the universities nor the technical colleges in themselves are capable of rendering a new educational service to British industry. They are hide-bound by tradition and they are blinded by social and intellectual snobbery. Unfortunately neither are eminently suited to face the real problem of technological education.

Theory and Practice

One of the greatest needs is to encourage in the youth from 16 years onwards that the subject of his study has real importance and the reality of its importance can only be emphasised if he has an opportunity of intermingling his theory with the practice of the factory and workshop. We are not so short of theoretical chemists as we are of good works chemists. The familiar hexagon of the organic chemist passes into the limber of lost and forgotten things if he goes into industry but it assumes a form of devil worship if he goes into the university to teach.

The new technological institutions must be closely associated with industry. A little less didactic theoretical instruction would not come amiss. There is only one place to teach steel technology and that is in a steel foundry. You can learn about shipbuilding only in a shipyard. You can learn about coal

only in a coal mine. There is no need to spend millions of pounds building a gigantic educational edifice. There is little need to spend millions on university laboratories when the British workshops and factories are available for practical instruction. We are not short of facilities for theoretical education—in fact we are glutted with it and as a result purely theoretical conclusions are endowed with the mantle of truth.

We have enough facilities for advanced education, but we lack the means of providing good foremen, good charge hands, good production engineers, good works managers and good managing directors. The managing director who can still take off his coat and operate a capstan lathe in the presence of his workmen will never lose cast and the best works managers and managing directors of British industry have started from the bench. Not unnaturally they view with a somewhat cold eye, the modern university product with his air of superimportance and his demand for an exorbitant salary without any practical training.

An Institute of Steel

To meet the demands of industry any expense which is contemplated should be directed towards better technical training at the foreman level. There seems to be no reason why there should not be a Steel Institute in Sheffield with a 4 or 5 year course which recruited students at 16 or 17 and gave them a theoretical and practical training. It does not require much foresight to imagine that at least after the first year students could be paid for doing a practical job. There seems no reason why at the end of this period of study they should not have a diploma, certificate, degree or what you will, which has the corresponding social and cultural value as the B.Sc. or B.A. Such a system would enable the best to go on further to a specialised technological course whilst those of not such high calibre could pass directly into industry as trained engineers.

As far as the teaching staff is concerned they might not be deeply steeped in psychology and the ethics of education but the man in the toolroom will teach a boy to make tools much better that the heavily belettered University Don. We are not particularly concerned with the status of the university or the technical college. They fulfil a useful function and are doing a definite job but these new institutes as outlined above for coal, steel, shipbuilding, textiles and so on would cost relatively little in capital cost. They would increase the labour force available to industry. They would incalculate the idea of the importance of industry to our national economy and in 10 years they could raise the industrial standard of the British workman to unprecedented heights.

Apprenticeship System.

This is of course a revival of the old apprenticeship system amidst modern surroundings—but that much despised system threw a dual responsibility upon the employer and apprentice and produced better craftsmen than exist today. From 1920 to 1940 we produced relatively few trained apprentices in the heavy industries and today the semi-skilled labour of the German, Dutch and Scandinavian countries is equivalent to the best of our skilled labour. But there one finds that for many years the universities have been unseated as the technological centres of education. There is the renowned Swiss Federal Institute of Technology at Zurich. There are the Technical High Schools of Stockholm and Gothenburg. There is the Swedish University of Commerce for post graduate research in business, and of course the Massachusetts Institute of Technology.

All of these rank in social and commercial status with the universities but are unencumbered by them.

A Job for Industry

Then again the question of who will control these newer institutions arises. They can be provided by the state out the exchequer funds and run by the Civil Service. But even the most unenlightened Socialist must realise that such centralised control soon gets out of touch with reality. It would be better by far if

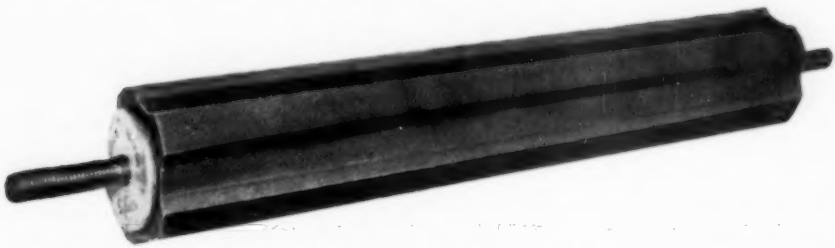
industry were to provide the newer Technical Institutes themselves. Is it beyond the scope of organisations such as the Steel Federation to set up an Institute of Steel Technology in Sheffield. The resources of the University of Sheffield are available for theoretical work and the most modern steel plants are there for practical work. If young students were given an opportunity of 4 years for a university degree without an opportunity of earning a wage or of completing a course in which they fitted into the factory as wage earners and simultaneously pursued their studies to obtain at the end a degree of equivalent status, it is obvious that many would choose the latter. Maybe such a scheme would sound the deathknell of the present day faculties of pure science in our universities but they deserve to go.

It is beyond the comprehension of any industrialist that a boy can proceed through the university towards a degree in chemistry with the object of becoming a works chemist without ever seeing the inside of a chemical works and taught by staff who have had no commercial experience of the practice of their craft.

No wonder that an author said recently that "Science is a Sacred Cow!"

RAPPING ROLLER FOR BELT CLEANING

RICHARD SUTCLIFFE LTD., Universal Works, Horbury, Wakefield, Yorkshire, are now supplying a new type of belt cleaner. The rapping roller, as it is known, has been introduced to serve the dual purpose of centralising the load on top belts and removing dust or sticky materials from the return belt of conveyors. The roller consists of a heavy-duty idler roller, to which four or more ribs of specially compounded rubber are permanently vulcanised. As the roller revolves, the ribs tap the belt lightly; this vibrating effect causes an oscillatory movement of the belt and centralises the load. When the roller is used with the bottom belt, it sets up the same conditions, and removes the adhering dust or sticky material. The special rubber compound used ensures that the clinging material does not stick to the roller, and its efficiency is therefore continuous and without need for attention. The tracking of the belt is not affected by the use of the rapping roller. When the roller is used in conjunction with a dust suppression box it forms an effective and easy method of belt cleaning.



Examples of the "Sutcliffe" Rapping Roller

Mechanical Aids to Decorating Ceramic Ware

SPECIALLY CONTRIBUTED

IT has been stated that the decoration sells pottery, and to a great extent this statement is true, for only the more technically minded can appreciate quality in the body or glaze. Thus it has come about that decoration has become vital, especially for the export market.

In earlier times the decoration relied on the use of engobes and hand painting exclusively, and later relief decoration was added ("sprigging"). Commercially, decorating has mainly become, now, a matter of applying a design either under or on glaze, and engobe and slip decorations find their main application for studio pottery.

Faced with the tremendous demand for decorated ware, the industry has found it impossible to obtain enough skilled decorators, and hence, means have had to be devised to cut out the monotonous and laborious parts of decorating processes so as to allow the labour released to be more usefully employed. Insofar as this makes the work more congenial and cuts production costs without sacrificing quality, this trend is to be welcomed.

Mechanical aids to decoration are, of course, no new thing and they have put the price of decorated pottery and glass well within the ability of the masses to purchase. At present, we know that there are reasons why decorated ware cannot be made immediately available to the general public, but it has recently been stated in Parliament that ways and means are being explored to see whether some decorated ware cannot be made more generally available. Mechanical aids will undoubtably help this.

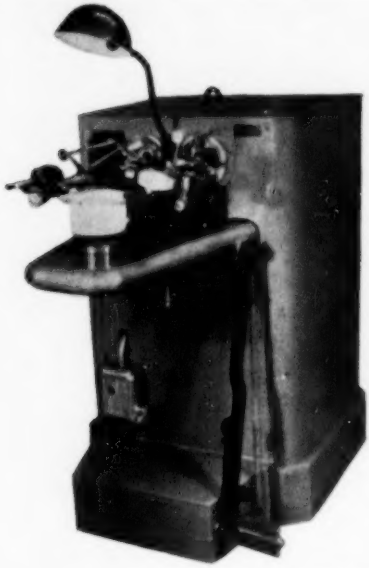
Printing

The earliest mechanical means of decorating pottery was printing. L. H. Latchford (*Trans. Brit. Ceram. Soc.* **34**.417.1934-5) states that line engraving was first commenced in Florence in the 15th Century and brought to England in the 1640's. The early and middle 18th Century saw a great development of the work in this country. Ravenet is stated to be the first engraver to have recognised the need for deeper cut engravings for reproducing prints on pottery. He was a Frenchman who was brought over to this country by Hogarth. The exact date of the first decoration of pottery is uncertain.

The blue willow pattern, which stimulated a huge demand for printed ware, was introduced by Turner of Caughley in 1780—it was an underglaze decoration (cf. W. Turner's "Transfer Printing on Enamels, Porcelain and Pottery," London, 1907). On-glaze decoration by printing had been done many years previously. The credit for this is commonly given to Sadler and Green of Liverpool, who patented the art of printing from copper plates on porcelain in 1757. The method was practised about the same time at Battersea, and was then taken up by Worcester, Derby and Caughley. Underglaze printing, according to W. Turner, was first done at Worcester in 1757 and later at Derby (1764), though he states that these dates are to be taken with caution.

Printing in Staffordshire

What is of interest is that many potters sent their ware, what were then considerable distances, to be decorated at Sadler and Green's factory in Liverpool. Wedgwood sent ware there in the early 1760's. According to Miss Meteyard ("Handbook to Wedgwood Ware") Wedgwood was in London in 1765 seeking in the London print shops for a design for decorating "Queen's Ware," and it is probable that this fine cream ware



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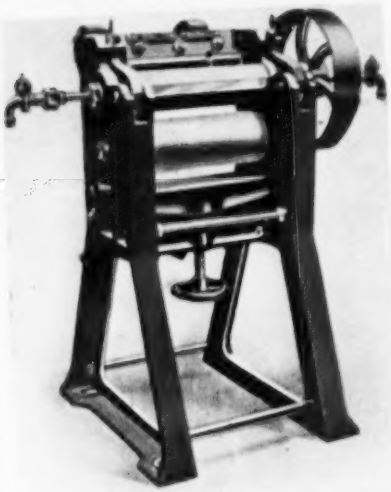

(Courtesy, Wm. Boulton Ltd., Burslem.)

Fig. 1. Boulton steam printing machine

was sent to Liverpool in 1762-65. This continued till his death in 1795.

In view of the difficulties of transport it was not surprising that the Staffordshire potters should attempt to carry out their own pottery printing. It is stated that Wedgwood commenced overglaze printing at Etruria in 1784, and after his death underglaze blue printing was commenced with a staff of printers recruited from Liverpool.

Previous to this, transfer printing had been introduced into Staffordshire by William Adams of Cowbridge. The first underglaze blue printing in Staffordshire is stated to have been done by John Turner of Lane End, and Josiah Spode followed with his underglaze willow pattern (c. 1784), and a very superior type of printed ware was turned out by Thomas Minton about 1793. As usual in those days the "secrets" of the art were obtained by bringing in workmen from outside works where printing was practised.

By this time printed ware was taking the place of the English salt-glazed ware and the era when British pottery was to flood the European market had commenced.

Mechanical Printing With Rollers

All the early engravings were done on flat copper plates which were inked with rollers and this practice continued for a century. It is still used where the number of prints required is not sufficient to justify the expense of engraving a roller.

The first roller printing machine was invented by Turner and called the "Steam Bob." The engraving was done direct on the roller, which was fashioned in one piece with the mandril, giving a heavy affair difficult for the engraver to manipulate. Twenty years later the interchangeable roller machine was perfected. These machines speeded up the production of prints and have to a great extent superceded the plate process where a large quantity of prints is required.

A typical modern printing machine is shown in Fig. 1. It consists simply of two rollers which are heated by some suitable means (commonly electricity or waste steam). The top roller is engraved with the pattern and it rotates against a pair of steel blades. In the hollow between the blade and the curvature of the roller the colour (made up with printer's oil in the usual way) is placed. The heat in the roller is adjusted to give the colour a suitable viscosity. As the roller rotates it picks up the colour and the knife then scrapes off the surplus, leaving it only in the design cut in the engraving. The adjustment of the knife has to be watched so that all excess colour is scraped off, otherwise dirty prints are obtained. Similarly, too little clearance between the rollers and the scraper may give excessive wear on the engraved roller. The latter is usually chromium plated.

The transfer paper is simply fed through the rollers and after receiving the print it is cut into convenient lengths. These machines are easy to work, give little trouble, and the rollers can be changed in about three minutes. Gas, electricity or steam can be used for heating.

Rubbing Down the Prints

Having mechanised the production of the transfers, it is not surprising that inventors should turn their attention to the next process of rubbing these down on to the ware. This is a very essential process and needs care on curved surfaces, as uneven pressure might result in a weak and uneven

pattern, or the paper might even be soaked away without the pattern having been transferred to the ware.

Rubbing down is commonly done with flannel pads or hard brushes. To do this at speed is a hard and monotonous occupation which ties up a lot of labour. Moreover, with embossed or similar ware, it is very difficult to ensure that the transfer is adequately rubbed down on the ware.

Great interest has been taken in late years in machines for doing this necessary work. The earliest of these employed a press in which the transfer paper was first lightly fixed to the ware, and then pressure applied with a metal plate faced with sorbo rubber to get down into the grooves, etc. of the article. An early difficulty was to get quick release of the article from the press, since a partial vacuum held the article to the press plate after pressing. This was overcome by drilling holes in the plate to release the vacuum.

From flat ware it was a logical step to extend the use of these machines to articles like cups. Figs. 2 and 3 show machines which will rub eight difficult prints per minute on flat. These would take two minutes of hard rubbing each to do by hand. The cup rubbing machine will deal with six articles per minute, putting a print on the inside, the outside, and stamping the bottom and handle all in one operation. The machines shown (Figs. 1, 2 and 3) are made by Wm. Boulton Ltd., of Burslem, Stoke-on-Trent.

The Pressure Box

Another simple machine which is used, particularly when the ware contains embossing, which renders transferring difficult, is the pressure box. In this the transfer is lightly fixed to the ware with gum and then the article is placed in a small steel box fitted with an air-tight shutter. After closing this, air is admitted at a pressure of 30 lb./sq. in. and held steady for a few seconds. The pressure is then released and the article removed with the transfer firmly attached. It is claimed that this gives perfect results even on the most difficult shaped ware.

New Developments

A recent innovation is a machine for rubbing down prints developed by

Fig. 2. Print rubbing machine for cups

(Courtesy, Wm. Boulton Ltd., Burslem.)

the British United Shoe Machinery Co., of Leicester (Fig. 5). Two of these machines are in use at Booth's pottery at Tunstall. It is claimed that these fix the prints even on the most difficult ware in a more satisfactory way than any other machine so far evolved.

Briefly, the machine consists of two steel pots which can be operated alternately. In each there is a pair of rubber diaphragms, which can be inflated with compressed air, shaped to suit the article. The steel pots are trapped when the sections of the steel pot are closing.

The ware, to which the print has been lightly fixed by rubbing with a flannel pad, is put on the lower rubber pad in the pot. The operative pulls the two handles and the pot closes, the vacuum operates, followed by the pressure. As the pot closes the rubber is sprayed with water to soften the paper. Using this machine, an output of twelve to thirteen pieces of flat or hollow ware per minute can be achieved and weekly outputs have exceeded

Fig. 3. Print rubbing machine for flat

(Courtesy, Wm. Boulton Ltd., Burslem.)

in two halves with a diaphragm in each half, and it is impossible to apply the air pressure until the sections are firmly locked together.

The pot is tested to stand pressures up to 100 lb./sq. in. A novel feature of this apparatus is that before applying the air pressure, the chamber is evacuated to remove air from the space between the print paper and the ware. The duration of the vacuum and the subsequent pressure application can be varied by simply rotating a dial on the machine. The latter is operated by pulling two handles, so that it is impossible for hands to be

1,500 dozens. Even with embossed ware the prints are firmly fixed. It has been possible to put a print on the inside of a cup handle quite successfully.

Ryckman Gold Lining Machine

Another noteworthy machine is one for putting gold lines and stippling on ware. This is the Ryckman edge-lining and stippling machine. Originally made in Canada, this machine is now manufactured in this country by F. Malkin and Co. Ltd., Chadwick Street, Longton, Stoke-on-Trent.

A photograph of the machine is

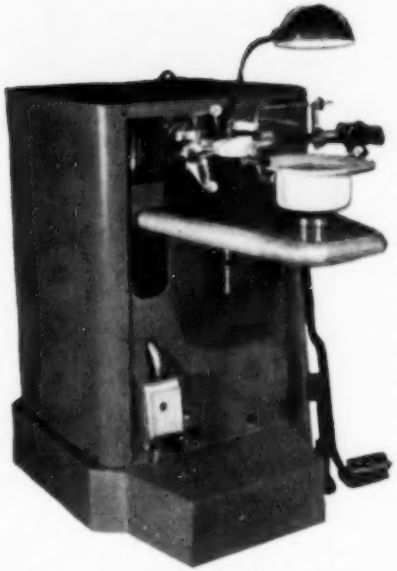

Fig. 4. Ryckman gold-edge line and stippling machine

(Courtesy, F. Malkin & Co. Ltd., Stoke-on-Trent.)

shown in Fig. 4. It consists essentially of two arms holding power-driven rubber rollers, which pick up the gold from fountains and transfer it to a second roller which runs on the ware. The latter is held on a plaster chuck which rotates freely under the frictional force between the ware and the rollers.

The chuck is held on a platform which can be raised and lowered by operating a foot pedal in order to change the pieces of ware being decorated. The line on the ware is that produced by the rotation of a wide roller in angular contact with the edge of the ware, and the production rate is dependent on the peripheral velocity possible for any given shape of ware. For deeply scalloped edges and square plates, a slower speed of say 200 lineal inches per minute would be used, while for plain edges on flat ware double this speed would be suitable. For stippling effects the plain roller is replaced with one of sorbo sponge. Other types of effects such as dotted bands are obtainable with suitable rollers.

Colour Drum

The left and right hand applicators are identical except for position of the fountain about the colour drum due to difference in direction of rotation on opposite sides of the ware. The colour drum rotates at a constant speed which is preset on a step-cone drive in the main transmission.

Three steps in the cone drive provide for different speeds of rotation. The gold solution is held in a well formed by the three sides and the bottom of the fountain and the rotating colour drum. A scraper blade, controlled by a pressure screw, works on the periphery of the colour drum and controls the amount of colour applied to the ware. The pressure is easily varied by adjusting a knurled screw. After passing under the scraper blade, the gold film is transferred to the applicator roller and thence to the ware. The actual area of contact between the colour drum and the applicator roller is small and most of the gold is carried back to the fountain.

The sides of the fountains are made as leak proof as possible by thin flexible wear plates held in position by the triangular shaped side plates, which are faced with neoprene. A

Fig. 5. Print rubbing machine

(Courtesy, British United Shoe Machinery Co., Leicester.)

transverse screw holds the assembly together and also adjusts the pressure exerted by the side plates on the colour wheel. In operation, this screw setting is adjusted to give minimum leakage, while not causing too much friction on the wheel.

Proper viscosity of the gold solution is essential for the best operation, and if the material tends to go tacky, it may be necessary to clean the edge of the drum from time to time with carbon tetrachloride. The applicator must not be allowed to run dry, or damage will be caused by non-lubricating surfaces rubbing together.

Width of Line

The width of the line can be varied in a number of ways:

(a) By altering the angle at which the roller runs on the ware. A line rolled on top of the ware tends to be wider than one rolled with the roller at an angle to the edge of the ware.

(b) By the use of harder or softer rollers—the latter give the wider lines.

(c) By altering the pressure on the rollers—greater pressure gives a thicker line.

(d) Extra thick lines can be traced by setting the two rollers at different angles to the ware, e.g., one horizontal and the other at 45° to the top edge.

Generally a minimum of two complete revolutions of the ware beneath the applicators is used.

A device is provided to enable plaster chucks to be made for various shaped articles.

Performance

Using this machine the following outputs are obtainable:

6 in. dia. flat—320 doz. of 12 in an 8-hr. day.

5 in. dia. saucers and muffins—300-350 doz. of 12 in the same time.

Other sizes give outputs in relation to their circumference and the nature of the edge.

It should be emphasised that these outputs are obtainable with an unskilled operator in a very short time. They represent about double the normal output of a gilder and liner, and in some cases it is possible to effect a saving in gold.

A logical development would now appear to be to devise a machine for lining on the face of the article as well as on the edge.

POTENTIAL USERS OF RADIO-ACTIVE TRACER ELEMENTS

SOME time ago the Sondes Place Research Institute of Dorking, Surrey, sent out a questionnaire to potential users of radio-active tracer element techniques, which included libraries, Universities, journals and Chambers of Commerce, together with general manufacturing firms in Britain, chemical manufacturers in Denmark, Norway, Sweden and Holland, Research Associations and Government Departments. The breakdown of the 8,730 sets of literature is as follows:

General manufacturing firms in Great Britain	7,120
Chemical manufacturers in Denmark, Norway, Sweden and Holland	1,350
Chemical consultants	150
Research Associations	50
Government Departments	60
	8,730

Replies were received from approximately 10 per cent. of the recipients, and of these 151 expressed interest in the technique. The classification of the interested replies related to specific industries is outlined as follows:

Chemicals	14
Food	14
Metallurgical	14
Pharmaceuticals	4
Leather	5
Engineering	23
Electrical engineering	7
Textiles	10
Ceramics	6
Glass	2
Paper	7
Rubber and plastics	6
Paint	5
Instruments	5
Oil	3
Sundry, including abrasives, soap, tobacco, adhesives, photography, etc.	25

It was interesting to note that eighteen firms stated that they either had, or had the intention of opening their own tracer laboratories.

Fused Vitreous Silica—Its Properties and Uses

PART I

Editorial article based on information contained in published papers and other data provided by The Thermal Syndicate Limited

THERE is no doubt that in Britain—and without exaggeration one might also claim, the world—the development of this material and its adaptation for a variety of uses has sprung ahead by British pioneering efforts. When one reads a paper entitled "History, Development and Commercial Uses of Fused Silica," presented by Sir Richard Arthur Surtees Paget to the Royal Society of Arts as far back as 1924, one is compelled to the conclusion that then, as now, more production and development knowledge was available in Britain than elsewhere. This is not unnatural when the list of names of early pioneers interesting themselves in the product is noted: There was Vernon Boys, Sir Charles Parsons, Threlfall, Shenstone, Lord Rayleigh, Frank Bottomley (really the discoverer of the present production process), Charles R. Darling, and so on. The site of the development was Wallsend-on-Tyne just after the turn of the century, and then in 1917 the Thermal Syndicate and the Silica Syndicate became associated.

In 1888 Sir Charles Parsons communicated to the Royal Society a series of experiments, including that of fusing silica sand by means of an electrically heated carbon rod embedded in the sand—the fusion being carried out inside a closed cylinder and under a pressure of 5 to 30 tons per sq. in.

Threlfall's "Laboratory Arts" (Macmillan 1898) describes the preparation

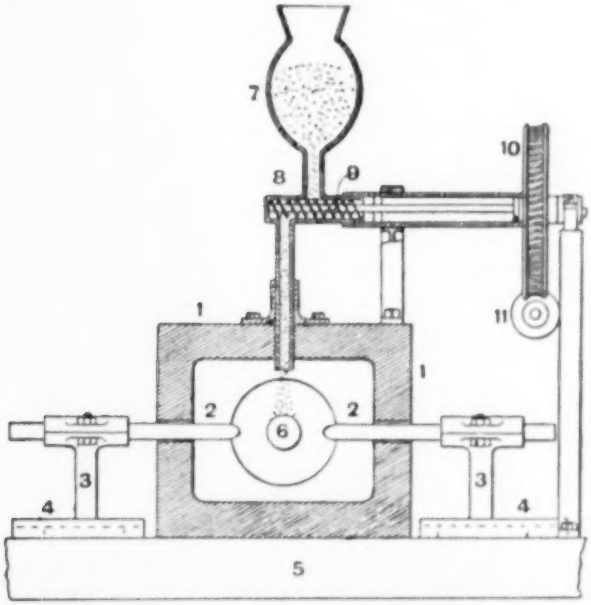

Fig. 1. Apparatus illustrating Kent's process of manufacturing transparent fused quartz as rod or tube

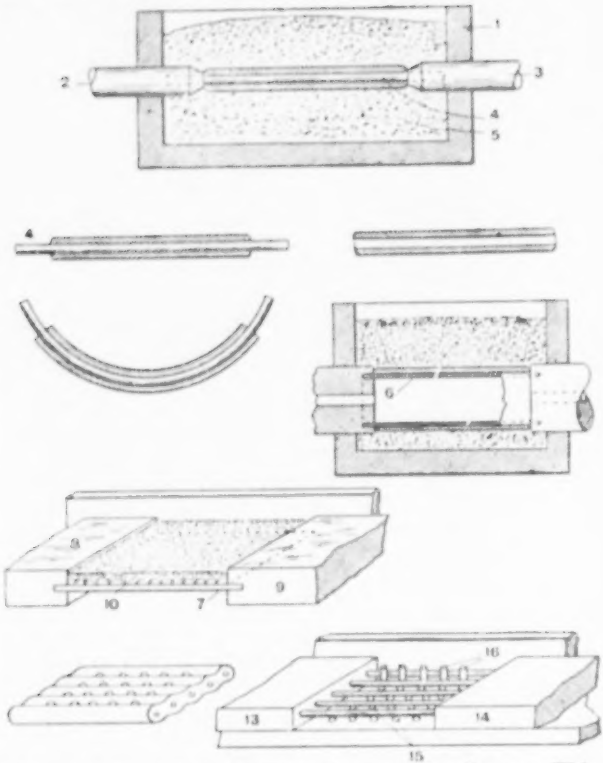

Fig. 2. Elihu Thomson's process for manufacturing tubes, etc.

of quartz fibres and the manufacture of insulators, etc. In 1899 Threlfall, at Oldbury, fused quartz in quantity in a 100 k.w. arc furnace, but did not succeed in working it.

In 1900 Schott and Genossen exhibited a fused quartz lens at the Paris Exhibition.

In 1901 Shenstone demonstrated at the Royal Institution his method of building up fused silica tubes by drawing pieces of rock crystal out into thin rods in the oxy-hydrogen blowpipe, assembling these faggot-wise round a platinum core and then fusing them together in the blowpipe.

In 1903 Heraeus, in Germany, exhibited apparatus of fused quartz, made by dropping rock crystal (previously heated above 660° C.) into an iridium tube furnace heated internally by oxy-hydrogen flames, and working the product in the blowpipe.

Shenstone's method was developed commercially by Johnson and Matthey, their organisation for this purpose being known as the Silica Syndicate. This Company made notable improvements in the manufacture of transparent fusions. Kent's method of building up a bubble free fusion (Fig. 1) consisted in feeding rock crystal powder into the heated zone. The mass thus formed was subsequently worked in the oxy-hydrogen blowpipe.

Heraeus's process was developed by his firm, W. C. Heraeus, of Hanau, which has continued to develop the use of transparent silica apparatus.

All these processes (except Sir Charles Parsons's) used rock crystal and produced a transparent glass-like product—more or less free from bubbles.

Complete freedom from bubbles is extremely difficult to attain owing to the fusion never becoming liquid. Subsequent research by Day and Shepherd showed that silica does not become liquid even when superheated at a pressure of 35 atmospheres.

Numerous proposals have been made to eliminate bubbles by fusing

silica in vacuo, with or without a subsequent compression of the plastic fusion. In 1904 and 1905, Bredel, in Germany, patented a process of fusing in vacuo and allowing the fused mass to flow into an evacuated mould, or of fusing *from below* in an evacuated furnace. In 1906 Wingrens, of Pasadena, Cal., patented a process of fusing in vacuo, and then subjecting the plastic fusion to gaseous pressure.

In the same year Day and Shepherd, of the Carnegie Institution, Washington, described the production of transparent silica plates by fusing rock crystal in an electrically-heated graphite box at 2,000° C., followed by further heating at 1,800° C., under a gaseous pressure of 500 lb. In 1907, Ludwig Bolle, in Germany, patented a process of silica fusion in a tubular furnace, the fusion being extruded by mechanical or gaseous pressure.

The inherent difficulty of fusing pure silica lies in the fact that, at the temperature of fusion, silica reacts with practically every known refractory material, except the refractory metals—platinum, iridium, etc., the cost of which is prohibitive, except for small scale operations.

Two Important Steps

In 1902 two important steps were taken. In the U.S.A. Elihu Thomson patented a method of forming articles of fused silica by a process similar to that of Sir C. Parsons, but working at atmospheric pressure. Thomson's heating core (Fig. 2) was of carbon or graphite and was so shaped as to form the mould or core for the ultimate product, i.e. fusion round a rod produced a tube of silica—a basin-shaped heating core produced (or was intended to produce) a silica basin. The carbon core, surrounded by the sand to be fused, was electrically heated (the electrical data were not disclosed in the patents) until the sand in contact with the core was melted to the required thickness. The current was then cut off, the fusion allowed to cool, and the fused mass mechanically separated from the cold core, or the core was burnt off by excess of oxygen.

In this country R. S. Hutton, of Owen's College, Manchester, who had previously worked with Moissan in France on the arc furnace, independently developed a very similar process.

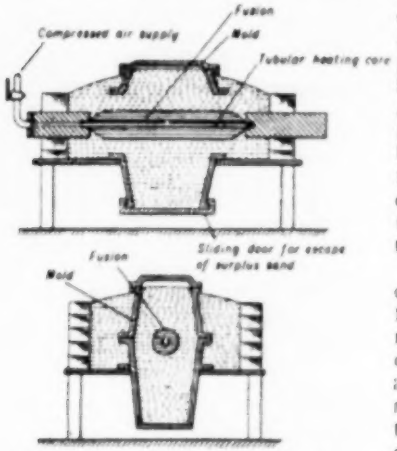

Fig. 3. Method of fusion by means of electric furnace

Wallsend Experiments

As a result of Lord Rayleigh's investigations experiments were started at Wallsend in 1903, with the object of developing, if possible, a commercial method of fusion by means of some form of electric furnace.

By working at a much higher temperature than Thomson and Hutton, and by carefully regulating the temperature, it was possible not merely to bring the whole fusion to a state of substantially uniform plasticity, but also so to regulate the interior gaseous pressure (due to CO and silica vapour formation) that the fusion *remained separated from the core* except at the relatively cool extremities of the core. Under these conditions there was no further reaction between silica and carbon, and the fusion could be blown up *in situ* into moulds surrounding the fusion (Fig. 3).

A little later it was found that the core could be withdrawn altogether from the fusion and the fusion itself removed from the furnace. Moreover, the fused mass—in the form of a large tubular sausage—was found to retain its plasticity for a considerable time, due to the heat insulating effects of the unfused sand which adheres to the fusion. In consequence of this, the fusion could be drawn into tubes

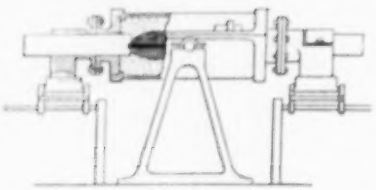

Fig. 4. Horizontal furnace for fusion and removal of plastic mass for shaping after removal of core. Bottomley and Paget's patent

or blown out into moulds, or pressed or rolled, *without reheating* (Fig. 4).

Later researches by other workers have shown that the change from crystalline quartz to amorphous silica begins at 1,470° C—that melting begins about 1,650°, and that the pasty condition is reached at between 1,750° and 1,800° C.

The material produced by drawing, blowing or pressing a sausage of fused silica sand differs from the products of Elihu Thomson and Hutton, in that the spherical bubbles of the former processes are drawn or spread out into threads or laminations, so that the material has a grain. This results in a characteristic change of appearance. The high lustre on the inside of blown fusions has a practical use in the case of electric and gas-lighting bowls—it has also been used for mosaic work.

The first important exhibition of vitreous silica ware or "Vitreosil" was made by the Thermal Syndicate at the Brussels Exhibition of 1910. These were the only exhibits (except those of platinum, shown by Johnson and Matthey) which survived the disastrous fire which destroyed the British Section.

Principal Properties

The principal properties of vitreous silica which make it valuable in the chemical and allied industries are as follows:

(1) *Chemical Resistance.* It is unaffected by halogens and acids regardless of temperature or concentration, with the exception of fluoric, hydrofluoric and phosphoric acids. The last affects the material only at high temperatures, and it is therefore possible to concentrate phosphoric acid successfully in vitreous silica vessels, and for all ordinary purposes they can be used with this acid. Strong alkalis react with it, but it is almost unaffected by water and therefore useful in preparing distilled water of very high purity, for example, for the preparation of fluorescent materials.

(2) *Homogeneity.* It is thoroughly uniform and homogeneous, free from the addition of any fluxes or other foreign material, and therefore remains constant in physical and chemical characteristics. Where the article possesses a glazed surface the glaze is formed by the fusion of the material itself and is not an added superficial layer liable to spall or craze. It is definitely part of the article and therefore has the same characteristics.

(3) *Impermeability.* It is not permeable to gases under ordinary pressures even at high temperatures, with the exception of helium and hydrogen, always provided that no devitrification has taken place.

(4) *Low Expansion.* The coefficient of expansion of vitreous silica is extremely small, the exact figure being 0.000000054, i.e. about 1-17th that of glass (Fig. 5).

The relative linear expansion of Vitreosil compared with that of some

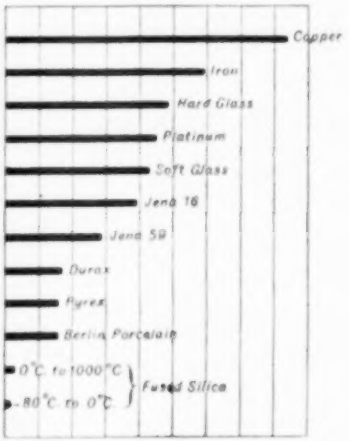

Fig. 5. Chart comparing various coefficients of expansion, drawn to proportionate scale

other well-known materials is shown in the following table:

	per ° C.
Vitreosil	0000054
Nickel Steel (Invar 36% Ni)	0000009
Porcelain (Berlin)	0000316
Glass, Chemical	0000032
Glass, Jena	0000057

Chiefly in consequence of this low expansion, it may be subjected to sudden and extreme temperature changes or shock without danger of breakage. This remarkable property can be demonstrated by dipping small red hot articles of vitreous silica into cold water without cracking or injury.

(5) *Resistance to Heat.* Although vitreous silica is extremely refractory, it has a tendency when subjected for long periods to a very high temperature to become brittle, and to change its physical characteristics. This, of course, is due to reversion from the vitreous to the crystalline state.

It may safely be used at temperatures up to 1,100° C. under ordinary working conditions and it may be used for short periods even up to 1,350° C. In addition, it can be used indefinitely up to 1,350° C., provided the temperature is maintained above 300° C. This enables it to be used for sighting tubes for optical pyrometers for furnaces which are in continuous operation. It is also successfully used for protection tubes for thermocouples, with which rapid readings may be taken up to about 1,700° C. This, taken in conjunction with its non-porous nature, renders it superior to other materials which have been suggested for the purpose.

(6) *Electrical Characteristics.* Pure fused silica possesses unique properties as an electrical insulator. For example, the resistance at ordinary temperatures is over 200,000,000 megohm-cm. for the translucent material and for transparent fused silica the value is even higher. The dielectric properties, high breakdown value, over 10 KV per mm. at ordinary temperatures, low power factor, of the order of 0·1 per cent., also show it to be in the highest class of insulating materials, the latter as regards minimum power losses at high frequencies. It is much superior to porcelain and other substances in withstanding high frequency discharges at high voltages as shown by the fact that a translucent fused silica insulator ½ in. thick showed no rise of temperature when subjected to peak voltages of 5,000—6,300 at 22,700 kilocycles for 30 min. Porcelain heated up to 112° C. and cracked after 10 min. at 4,200 kilocycles. It also maintains its insulating properties over a wide range of temperatures.

(To be continued)

BIRLEC LTD.

WE have received from the above company revised catalogue No. 59, dealing with Vertical Forced Air Circulation Furnaces. The booklet is extremely well illustrated and gives some interesting cross sections of typical installations. Reference is made to heat treatment up to 700° C. The principle of forced air circulation in relation to a specially developed centrifugal fan is outlined. There is a description of a Charge Progress Recorder which is designed to enable the operator to know when the charge itself—as distinct from the furnace—has reached the desired temperature. This is recorded automatically.

In addition, their leaflet, "Large Batch Type Heat Treatment Furnaces" is also available, in which reference is made to horizontal batch furnaces and vertical batch furnaces covering heat treatment, carbonising, vitreous enamelling, light alloy treatment, heavy heat treatment, bright annealing and nitriding.

Both leaflets are available from Birlec Ltd., Tyburn Road, Birmingham 24.

INDUSTRIAL PYROMETERS

WE have received a leaflet from the Industrial Pyrometer Co. Ltd., 29 Victoria Street, Birmingham 1, describing their range of industrial pyrometers.

They include wall indicators with both a 6 in. and 4 in. scale. Of interest is their Industrial Galvanometer, in which they make use of a recently-developed alloy steel possessing an extremely high magnetic flux density.

These indicators are fitted with scales which are individually produced and have calibration lengths of 4 in., 6 in. and 8 in.

Their Industrial Thermocouples are described for ranges up to 1,000° C., 110° C. or 1,400° C. for continuous use. In addition, there are special test Thermocouples listed as immersion types and surface contact types.

This leaflet is available on application to the firm.

A Gibbons Celebration

ON Saturday, 20th May, Gibbons Bros. organised a celebration trip to commemorate the hundredth tunnel kiln they have installed since the end of the war. Because it was felt that an analysis of the type of kiln, the fuel and the production, etc. would be of general interest to readers, this is appended below.

The trip was a great success, beginning from Dudley at 8 o'clock in the morning and leisurely wending its way through Bromsgrove, Alcester, Evesham, Broadway to Stow-on-the-Wold. Here that quaint part of England was inspected and the architectural beauties of the local inns was thoroughly studied both from inside and out! Thence the parties proceeded via Burford, Bibury to Cirencester, where they had lunch. Thence to Cheltenham and on through Tewksbury to Worcester for dinner at the Pack Horse Hotel.

In the programme it says "10.15 p.m. (perhaps)—leave Worcester for home."

It turns out now that Gibbons Bros. have installed 3·37 miles of kilns in the past five years.

EARTHENWARE

Company	Type of Kiln	Fuel	Length ft.	Length in.	Product	Built	Commissioned
J. & G. Meakin Ltd.	O.F.	C.G.	323	0	Bisque	'45	'47
Wedgwood & Co. Ltd.	O.F.	C.G.	168	0	Glost	'45	'46
Wood & Sons Ltd.	M.	C.G.	186	0	Glost	'45	'48
John Maddock & Sons Ltd.	M.	C.G.	151	0	Glost	'45	'47
Barker Bros. Ltd.	R.	E.	51	0	Dec.	'46	'46
J. & G. Meakin Ltd.	M.	C.G.	210	0	Glost	'46	'47
J. Broadhurst & Sons (1939) Ltd.	O.F.	C.G.	105	0	Glost	'46	'47
Sampson Bridgwood & Son Ltd.	O.F.	C.G.	139	0	Glost	'46	'47
Globe Pottery Co. Ltd.	M.	C.G.	210	0	Glost	'47	'47
W. H. Grindley & Co. Ltd.	O.F.	C.G.	214	0	Glost	'47	'48
Barker Bros. Ltd.	O.F.	C.G.	214	0	Bisque	'47	'48
Booths Ltd.	O.F.	C.G.	241	0	Bisque	'47	'48
Manuel Alvarez E. Hijos. S. L. Spain	M.	Oil	214	0	Bisque	'47	'49
Manuel Alvarez E. Hijos. S. L. Spain	M.	Oil	214	0	Glost	'47	'49
S. Fielding & Co. Ltd.	M.	C.G.	96	0	Dec.	'47/8	'49
Sampson Bridgwood & Son Ltd.	M.	C.G.	96	0	Dec.	'47/8	'48
Den Kongelige Porcelainsfabrik, Copenhagen	O.F.	C.G.	214	0	Bisque	'47/8	'48
N. V. Kristal-Glas En Aardewerkfabrieken "De Sphinx" Holland	M.C.	E.	80	0	Dec.	'47/8	'48
A. Clough Ltd.	S.E.	E.	115	0	Glost	'47/8	'48
S. Fielding & Co. Ltd.	M.	C.G.	126	0	Glost	'48	'48
A. G. Richardson & Co. Ltd.	M.	C.G.	96	0	Dec.	'48	'48
Wedgwood & Co. Ltd.	M.	C.G.	96	0	Dec.	'48/9	'49
Carter, Stabler & Adams Ltd.	{Special	E.	96	0	Bisque	'48/9	'49
	{Twin	E.	96	0	Glost	'48/9	'49
Wade Heat & Co. Ltd.	R.E.	E.	61	6	Dec.	'49	'49
Co-operative Wholesale Soc. Ltd.	R.E.	E.	47	0	Dec.	'48	'49
Stavanger Fajansefabrikk A/S., Norway	S.E.	E.	151	0	Bisque	'48/9	'49
Societe Ceramique, Holland	M.	C.G.	218	0	Glost	'49	'49
Stavanger Fajansefabrikk A/S., Norway	S.E.	E.	138	0	Glost	'48/9	'49
Societe Ceramique, Holland	M.	C.G.	218	0	Glost	'49	'49
J. Sadler & Sons Ltd.	M.	C.G.	96	0	Dec.	'49	'50
Myott, Son & Co. Ltd.	M.	C.G.	167	0	Glost	'49/50	'50
	32		4,847	6			

BONE CHINA

Company	Type of Kiln	Fuel	Length ft.	Length in.	Product	Built	Commissioned
Shelley Potteries Ltd.	Roto	E.	70	0	Dec.	'45	'46
Hudson & Middleton Ltd.	Roto	E.	70	0	Dec.	'46	'46
Thomas Poole (Longton) Ltd.	Roto	E.	70	0	Dec.	'46	'46
W. T. Copeland & Sons Ltd.	S.E.	E.	90	0	Glost	'46	'46
Paragon China Ltd.	S.E.	E.	119	0	Glost	'47	'47
Shore & Coggins Ltd.	Roto	E.	51	0	Dec.	'47	'47
E. Brain & Co. Ltd.	Roto	E.	51	0	Dec.	'47	'47
Royal Crown Derby Porcelain Co. Ltd.	M.C.	E.	70	0	Dec.	'47	'47

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CERAMICS

Company	Type of Kiln	Fuel	Length ft.	Length in.	Product	Built	Commissioned
T. C. Wild & Sons Ltd.	O.F.	C.G.	170	0	Bisque	'47	'48
Thomas Poole (Longton) Ltd.	S.E.	E.	119	0	Glost	'47	'48
Crown Staffordshire Porcelain Co. Ltd.	Roto	E.	51	0	Dec.	'47	'48
Hudson & Middleton Ltd.	S.E.	E.	106	0	Glost	'48	'48
Crown Staffordshire Porcelain Co. Ltd.	S.E.	E.	119	0	Glost	'48	'48
A. B. Jones & Sons	Roto	E.	51	0	Dec.	'48	'49
T. C. Wild & Sons Ltd.	O.F.	C.G.	170	0	Bisque	'48	'49
Shelley Potteries Ltd.	S.E.	E.	141	6	Glost	'48/9	'49
T. C. Wild & Sons Ltd.	Roto	E.	70	0	Dec.	'49	'49
Royal Crown Derby Porcelain Co. Ltd.	S.E.	E.	119	0	Glost	'49	'49
E. Brain & Co. Ltd.	Muffle	C.G.	106	0	Glost	'49	'49
Colclough China Ltd.	O.F.	C.G.	228	0	Bisque	'49	'50
J. Aynsley & Sons Ltd.	S.E.	E.	119	0	Glost	'49/50	'50
	21		2,160	6			

HOLLOW WARE

Company	Type of Kiln	Fuel	Length ft.	Length in.	Product	Built	Commissioned
Wiltshaw & Robinson Ltd.	S.E.	E.	85	0	Glost Fancies	'45	'45
Lovatt's Potteries Ltd.	M.	C.G.	232	0	Stoneware	'45/6	'46
Arthur Wood & Son (Longport) Ltd.	O.F.	C.G.	145	0	Teapots	'45	'46
Gibson & Sons Ltd.	M.	C.G.	186	0	Teapots	'46	'47
Thos. Lawrence (Longton) Ltd.	S.E.	E.	96	0	Glost Fancies	'47	'47
John Shaw & Sons (Longton) Ltd.	S.E.	E.	96	0	Glost Fancies	'48	'48
Wiltshaw & Robinson Ltd.	S.E.	E.	119	0	Biscuit Fancies	'48	'48
Parshuram Pottery Works Co. Ltd., Wankaner, India	M.	Oil	251	0	Mixed	'48	'49
Price Bros. (Burslem) Ltd.	O.F.	C.G.	169	0	Teapots	'49	'50
A. S. Knabstrup Teglvaerk	S.E.	E.	115	0	Mixed Holloware	'50	'50
	10		1,474	0			

SANITARY WARE

Company	Type of Kiln	Fuel	Length ft.	Length in.	Product	Built	Commissioned
S.G.B. (Dudley) Ltd.	M.	C.G.	580	0	Fireclay	'45/6	'46
Towneley Fireclay Co.	O.F.	C.G.	507	0	Fireclay	'46	'46
Shanks & Co. Ltd.	M.	H.P.G.	511	6	Earthenware, Bisque & Glost	'46	'47
Twyfords Ltd.	M.	C.G.	306	6	E. Bisque	'47/8	'48
Johnson Bros. (Hanley) Ltd.	M.	C.G. & C.P.G.	306	6	E. Glost	'47/8	'48
Johnson Fireclay Co. Ltd.	M.	H.P.G.	580	0	Fireclay	'47/8	'48
Johnson Bros. (Hanley) Ltd.	M.	C.G.	306	6	E. Bisque	'48	'48
Twyfords Ltd.	M.	C.G.	306	6	E. Bisque	'48	'48
Ed. Johns & Co. Ltd.	M.	Oil	311	6	E. Glost	'48	'49
Alfred Johnson & Son Ltd.	M.	Oil	306	6	E. Glost	'48	'49
Shanks & Co. Ltd.	M.	Oil	580	0	Fireclay	'48	'49
Faienceric De Keramis Boch Freres S. A. Belgium	M.	C.G.	364	0	Mixed	'48/9	'49
Associated Clay Industries Ltd.	M.	C.G.	306	6	E. Glost	'48/9	'49
Alfred Johnson & Son Ltd.	M.	Oil	306	6	E. Bisque	'48/9	'49
Ed. Johns & Co. Ltd.	M.	Oil	311	0	E. Bisque	'49	'50
J. Slater (Stoke) Ltd.	M.	Oil	580	0	Fireclay	'49	'50
Associated Clay Industries Ltd.	M.	C.G.	306	6	E. Bisque	'49/50	'50
	17		5,577	6			

WALL TILES

Company	Type of Kiln	Fuel	Length ft.	Length in.	Product	Built	Commissioned
H. & G. Thynne Ltd.	M.	C.G.	212	0	Glost	'46	'46
Campbell Tile Co. Ltd.	M.	C.G.	256	6	Bisque Glost	'46/7	'47
S.G.B. (Dudley) Ltd.	O.F.	C.G.	161	0	Bisque	'47	'48
S.G.B. (Dudley) Ltd.	M.	C.G.	173	0	Glost	'47	'48
G. Woolliscroft & Sons Ltd.	O.F.	C.G.	136	0	Glost	'48	'48
Cattanec & Cie. Argentine	M.	Oil	256	0	Glost	'48	'48
Richards Tiles Ltd.	O.F.	C.G. or C.P.G. or Oil	252	0	Bisque & Glost	'48/9	'49
	7		1,446	0			

ELECTRIC PORCELAIN

Company	Type of Kiln	Fuel	Length ft.	Length in.	Built	Commissioned
George Wade & Son Ltd.	S.M.	Oil	200	0	'47	'47
Wm. Kent (Porcelains) Ltd.	O.F.	C.G.	148	9	'47	'48
Taylor, Tunnicliff & Co. Ltd.	O.F.	C.G.	166	0	'48	'48
N. V. Phillips' Gloeilampenfabrieken, Eindhoven	O.F.	C.G.	142	6	'48	'49
Beusker's Apparatenfabrieken, N.V.	O.F.	C.G.	80	6	'48	'49
George Wade & Son Ltd.	O.F.	C.G.	152	6	'49	'49
Appareillage Electrique D. Tinlot	O.F.	C.G.	80	6	'50	'50
	7		970	9		

MISCELLANEOUS

Company	Type of Kiln	Fuel	Length ft.	Length in.	Product	Built	Commissioned
Reckitt & Colman Ltd.	S.M.	C.G.	125	0	Chemical	'47	'47
English Clays Lovering Pochin & Co. Ltd.	O.F.	Oil	182	0	Molochite	'46	'48
N. V. Alfred Regout & Co., Holland	O.F.	C.G.	249	0	Floor Tiles	'48	'49
Gebr. Laumans, Holland	O.F.	C.G.	312	6	Roofing Tiles	'48/9	'49
Gibbons (Dudley) Ltd.	O.F.	C.P.G.	305	0	Large Fire Bricks	'48/9	'49
Richards Tiles Ltd.	O.F.	C.P.G.	166	0	Saggars	'49	'49
	6		1,337	0			

KEY

For type of kiln read as follows:

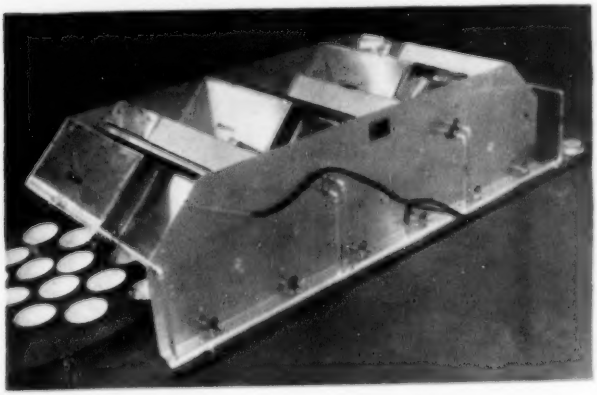
S.M.	Semi Muffle.
M.	Muffle.
O.F.	Open Flame.
M.C.	Moore Campbell.
S.E.	Straight Electric.
Roto	Circular Electr.c.

For fuels read as follows:

E.	Electricity.
C.G.	City Gas.
C.P.G.	Clean Producer Gas.
H.P.G.	Hot Producer Gas.

RADIANT HEAT GLAZE DRYER

AN interesting development has been an infra-red gas-fired glaze drying plant which was supplied to Oy Arabia Ab, Helsinki. It is shown in the illustration and has a drying time of 2-3 min., in place of 30 min. by the previously used hot air system. The radiant heat is provided by six Bratt Colbran industrial units. It has a gas rate of 600 c. ft. per hr. and was built to the specification of Neil and Spencer Ltd., Station Road, Leatherhead, Surrey.



Infra-red gas-fired glaze drying unit, built to the specification of Neil and Spencer Ltd., and incorporating six Bratt Colbran industrial units

The Markets for Pottery

by

BERNARD HOLLOWOOD

More than anything, at the present time, the pottery industry in Britain needs the advice and service of an export trade promotion authority, states the author of this article. He contends that a huge, world-wide trade exists, and that a large measure of that trade could and should belong to Britain. The arguments developed are mainly directed to British manufacturers, but their significance are not without considerable interest to all overseas readers.

ALTHOUGH the pottery industry is likely to be the last of Britain's exporting industries (with the possible exception of whisky) to experience that chill feeling of fear and doubt which signals the transition from a sellers' to a buyers' market, it is by no means unprepared for the shock. The wonder, to most people connected with the industry, is that the sellers' market has lasted so long.

As soon as legitimate trading was resumed after the war the murky atmosphere of "the Potteries" of North Staffordshire became thick with woeful forecasts. "The sellers' market," said the experts, "will last only a few months, a year at most, and then dull depression will begin to settle on the industry as it did after the first world war. It will take Japan and Germany only a little time to recover, and then their competition will be fiercer than ever."

Overseas Demand

Well, the expected did not happen. Four and a half years after the end of hostilities, the world's markets—most of them—are still clamouring for British pottery. The fact that the manufacturers of bone china were able to increase their export prices by 10 per cent. when the pound sterling was devalued last September is sufficient proof. This does not mean that the order books are as full as they were three or four years ago, or that the markets still buy as indiscriminately as they did then, but the demand for British pottery overseas is still, at the beginning of 1950, much greater than the supply. And the supply is about 40 per cent. of total production: the other 60 per cent. of undecorated or "utility" ware being retained for the home market.

Let us take a look at the position in the world's markets before the war. In 1937, the world's export trade in pottery was shared by Japan (36 per cent.), Britain (32 per cent.), Germany (18 per cent.), Czechoslovakia (11 per cent.), and France (3 per cent.). Other countries—Italy, Poland, Sweden and the United States—exported in only small quantities.

The growth of Japanese trade in the inter-war years was phenomenal. It had mushroomed from almost nothing to make Japan easily the largest of the world's exporters. In 1937 the Japanese exported 180 million tea-sets (mostly of cheap grades and nearly all decorated either in oriental designs or in imitation of Staffordshire products) and 25 million dozen of other tableware.

Almost everywhere in the Commonwealth, in Europe, in the United States, these wares were ousting the British. They were very much lower

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(b) A modification of kiln (a) suitable for the firing of statuettes and other tall ware. Provision is made for accommodating three shelves for carrying smaller ware. The size of this kiln is 11 in. wide by 1 ft. 7 in. high by 2 ft. long.

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in price and their quality, though much inferior to Staffordshire's worst, was rapidly improving. After 1932 the Japanese pottery industry was organised as a cartel under Government supervision; production and export quotas were fixed and prices and grades were standardised. And these changes proved extremely successful—right up to Pearl Harbour.

Japanese Competition

In 1945 the Japanese ceramic industry was in a very sorry state. Its production had been destroyed by the war, its workers had been dispersed, its overseas selling organisation was broken up, and its goodwill was at zero.

Reconstruction was slow, although the MacArthur administration encouraged the revival of potting as a "safe" occupation. Now, it seems, the Japanese potters are once again in their stride; their goods have appeared in many of the old markets and have already made considerable headway in the United States and Canada. It can only be a matter of time before this threat to British trade is as strong as in pre-war days.

Recovery in Germany and Czechoslovakia has been slower, but the latest reports tell of steadily rising production, the modernisation of factories and a resumption of export trade.

The most important development over the past decade has been the rapid rise of the United States pottery industry. Before the war America produced about as much pottery as Great Britain, but most of this was absorbed by the vast home market and very little competed elsewhere with British wares. During the war, however, America was the only country in the world to improve its potting plant and equipment.

American Expansion

A report of the United States Tariff Commission (War Changes in Industry Series, No. 7, 1944) shows how expansion was achieved: "... the disproportion between demand and supply has been greater in household chinaware than in hotel china and earthenware because of the almost exclusive pre-war dependence on imports for household china. A great incentive to expansion of the domestic household china industry was offered. In contrast to the hotel ware and earthenware branches, no unused capacity was available, because the potential capacity for household china production was largely in the hotel china plants and the Government had called on these facilities for military supplies." The result was that domestic production of household china increased rapidly, and the pace was quickened after the war.

Today the American pottery industry is largely on a mass-production basis and the economics inherent in this system are such that in spite of the higher wages of American pottery workers costs and prices have been brought down very considerably. By the time that British pots have surmounted the American tariff they are usually at a disadvantage in price against all competing wares. That they contrive to sell easily is, of course, a tribute to their quality which is still pre-eminent.

Beauty and Strength

Bone china is a peculiarly British material, a china of great beauty, translucency and strength. Most of it is produced in the Longton district of the Potteries at more than one hundred factories. English bone china has enjoyed a high reputation in the world's markets ever since the days of the pioneer Spode. Before the war (1938) it accounted for only about one-tenth of Britain's pottery exports with a total value of £424,000; today overseas sales of bone china stand at nearly £3 million a year or more than one-seventh of the pottery industry's contribution to the export problem. And here "pottery industry" is used in its widest sense to include glazed tiles, sanitary ware, electrical ware, electrical porcelain and all tablewares.

Two Important Changes

There have been two important changes in the direction of this trade. In 1938, 26 per cent. went to Australia and New Zealand; now the figure is only 15 per cent. In 1938, the United States took 15 per cent.; now it takes 22 per cent. Thus the diversion has been at the expense of the southern Dominions and to the advantage of America.

In the short period it is also, of course, an advantage to a Britain in pursuit of elusive dollars; but the china manufacturers are far from happy about the longer view. They are afraid that continued neglect of old customers in the Dominions will eventually drive them to seek supplies elsewhere—as indeed is already happening to some extent in Australia.

The loss of valuable goodwill must be balanced against an immediate gain in dollars, which may or may not be permanent. Can the bone china trade hold its American market? Will the American housewife continue to buy British against low-priced competition from Japan? And how long will she buy imported china in preference to domestically-produced earthenware and semi-porcelain? Only, it is said, while the United States avoids recession or depression and wages and employment are good.

On the other hand there is no doubt that the bone china market in America could be greatly expanded. It is a commodity without any serious rivals so far as quality is concerned, and it would enjoy a vastly increased sale if this quality were more widely appreciated. Unfortunately the bone china manufacturer is a relatively small unit, ill-equipped to tackle the necessary and expensive work of peddling the ware throughout the forty-eight States.

Britain's export trade in pottery (and this time we mean china *and* earthenware) has always been in a comparatively few hands; more than half the total trade is done by ten large firms out of about one hundred engaged in exports—and nearly all of these ten are primarily manufacturers of earthenware. The lesson is an obvious one; there is an urgent need for some new form of export promotion organisation in the bone china section of the industry. Individually the firms are quite incapable of opening up new trading territories. In co-operation the task would not be beyond them.

Criticism and Defence

It is as well to admit here that opinions differ in this matter—as they have always done. One important critic of the British supply system to the United States is Mr. Neville Blond, United Kingdom Trade Advisor in the United States. Mr. Blond believes (according to a recent *Board of Trade Journal* article) that British pottery is not getting the kind of distribution it needs, that there is a marked tendency for sales to be confined very largely to the eastern states and particularly to New York; and that this is a misguided policy since the ignored Middle West has a potential buying power at least 50 per cent. higher *per capita* than New York and will become a lost market unless it is afforded better treatment in the near future.

All this, however, is energetically refuted by the United States import agents who maintain that the coverage achieved by their salesmen is high, wide and handsome. Clearly both sides to the controversy cannot be wholly right, and the chances are that Mr. Blond aims too high while his detractors aim too low.

It may well be that the problem of ploughing and sowing the American market *thoroughly* with good propaganda and salesmanship is too big for the pottery industry, that to spread their resources too thinly over a vast territory would be less advantageous in the long run than to plough thoroughly in selected localities. But so far there has been no conscious planning of distribution or promotion for the industry *as a whole*, and no enquiry has been conducted as a basis for any such planning.

Comparative Export Figures

The problem of distribution applies with equal force to the earthenware section of the industry which now earns nearly nine million pounds a year with its exports. The table on page 194 shows the value of earthenware exports for the two years 1938 and 1948, by countries.

It will be noted that Canada has now ceased to be the principal market for British earthenware exports and that its place has been taken by Australia.

A Solid Basis

On the subject of exports the Pottery Working Party was not particularly helpful. In its report it confined its remarks to a number of lukewarm recommendations:—

"Export efficiency could be promoted to some extent by lessening or removing those export 'mysteries'

	1938	1948
To Eire	44,103	218,750
„ British West Africa	3,992	82,001
„ South Africa	147,584	792,102
„ India, Pakistan	42,039	168,624
„ Australia	348,257	2,248,868
„ New Zealand	148,244	470,129
„ Canada	527,271	1,824,858
„ Other British Countries	100,561	567,217
„ Norway	29,998	39,674
„ Denmark	44,426	19,641
„ U.S.A.	215,022	876,106
„ Brazil	34,003	114,400
„ Argentina	108,769	417,527
„ Other Foreign Countries	205,530	847,557
Totals	£1,999,799	£8,687,454

(insurance, tariffs, packing, etc.) which seem to add to the perplexities and risks."

"In the interests of export trade their production (the manufacturers') should be helped in every way possible—building licences, machinery priorities, business visits overseas, and so on."

"Nevertheless, we urge the Federation (Pottery Manufacturers') to do their best to set up a co-operative export merchanting service to develop markets in which the small producer has a chance to retain an export trade."

It made the mistake of dealing with the export problem as a purely temporary quest for dollars and fixed its target very little higher than the pre-war capacity of the industry. Yet, this is an industry fully capable of enormous expansion, one of the few industries in which Britain has real advantages over all her competitors.

These advantages will be familiar to most readers, but it is as well to record them:—

1. *The fact that the industry is almost self-supporting in the matter of raw materials. Ninety-five per cent. of its clays, fuel, etc., are home-produced, so that exports are requited in full.*
2. *Assured and readily accessible supplies of first-rate raw materials.*
3. *Its goods have one of the highest values, bulk for bulk, of any exporting industry, and therefore relatively cheap transport charges.*
4. *A long tradition of potting and a fine reserve of skilled labour with real experience and know-how.*
5. *Expert designers, chemists and engineers.*
6. *The goodwill of every important market.*

On this solid basis it should not be difficult for the industry to rise to a position of complete supremacy in world markets, yet before the war countries with fewer national or acquired advantages were already abreast and beginning to draw ahead. It would seem that too many of our manufacturers then regarded the export trade merely as an outlet for goods difficult to dispose of at home. When they sold abroad they tended to sell almost exclusively to the English-speaking world—as though the barrier of language was not really worth the trouble of surmounting.

For example, Britain supplied only 8 per cent. of the pottery imports of Europe as against 50 per cent. by Germany and 31 per cent. by Czechoslovakia; only 35 per cent. of the imports of Africa, a continent largely under British control or influence, only 13 per cent. of Asian imports, against 77 per cent. by Japan; and 30 per cent. of Latin-American imports, against 33 per cent. by Japan and 27 per cent. by Germany.

For Britain to hold only 32 per cent. of the world's trade in pottery is not good enough, when it could, without undue work or difficulty be stepped up to 50 per cent. More than anything at the present time the pottery industry needs the advice and service

of an export trade promotion authority. It needs to know what are the precise requirements and demand schedules of those markets which have so far been largely ignored; it needs an export organisation that will relieve the manufacturer of the "mysteries" of shipping, tariffs, insurance and so on and enable him to get down to the urgent task of expanding production.

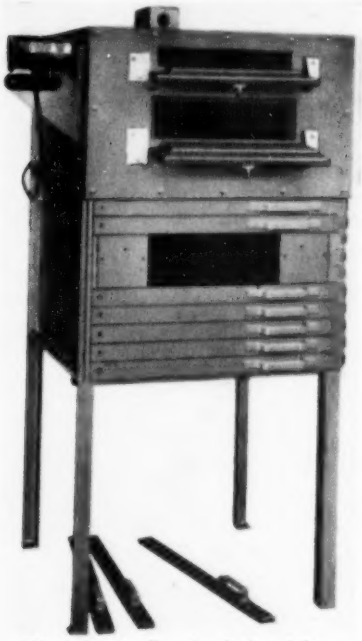
The trade is there to be had; it could and should be Britain's.

(Reproduced by permission of *British Production*)

"GRAFTON" STAINED GLASS KILN

WE have received information from The Applied Heat Co. Ltd., Elecfurn Works, Watford By-Pass, Watford, Herts, on one of their new kilns.

Considerable advantages are claimed for the use of electrical firing in place of gas or solid fuel for stained glass. The burning of the glass requires exact control of the heating conditions and an even temperature and accurate radiant heating falling uniformly on the trays, together with an ability to vary the working temperature easily, are most important.



The "Grafton" stained glass kiln, Model SGC.2

When kilns fall short of these requirements, trouble occurs. In addition, the chamber atmosphere must not be contaminated with products of combustion, particularly the oxides of sulphur. The Grafton electric stained glass kiln is designed specifically to eliminate these defects, and the Model SGC.2 is shown here. It is claimed that the operator can take advantage of the full capacity of the trays with no risk of unequal heating and no sulphur contamination. It is also claimed that this electric kiln costs considerably less to run than its gas firing counterparts, and in one set of figures the saving over twelve months was claimed to be 40 per cent. per annum.

The booklet describing this new kiln is available from the firm and it gives dimensions and ratings together with approximate shipping particulars.

VISCO DUST COLLECTORS

WE have received a leaflet, No. 469/2, from the Visco Engineering Co. Ltd., Stafford Road, Croydon, in which they describe their Unit Dust Collectors for tool and cutter grinders, surface grinders, cylinder grinders, fettling machines and polishing machines.

They are particularly designed for use in factories using abrasive wheels to collect light airborne dust given off from grinding and polishing machines.

The units can be supplied to deal with either hard or soft materials, abrasives, rubber, plastics, asbestos and so on. Basically they comprise a sheet steel casing, inside which is a battery of cloth tubes with a hand-operated shaking gear for easy release of the dust from the filtering medium. The dust falls to an assembly tray or drawer at the bottom of the casing. A centrifugal suction fan is part of the installation and is driven by a flange-mounted motor developing ½ h.p. at 2,800 r.p.m.

The leaflet gives design data on the units themselves. If details of the machines in which dust collecting plant is required are forwarded, the firm will quote for a specific installation.

Palladium.—There are two little booklets published by the Platinum Metals Division of the Mond Nickel Co. Ltd., Sunderland House, Grosvenor Street, W.1, dealing with the use of Palladium as a precious jewellery metal. There is a short introduction outlining the history and origin of this metal and a résumé of its use in the jewellery trade.

Vitreous Enamels

Composition and Application Methods

Part 1

by

Mr. S. HALLSWORTH
(Metal Porcelain Limited)

A course of lectures on Modern Developments in Metal Finishing was recently held at the Northampton Polytechnic, London, and the following contribution is reproduced by arrangement with the Polytechnic and the author.

VITREOUS enamel may be briefly but aptly described as "glass fused on metal." That is something which we try to emphasise as far as the vitreous enamelling industry is concerned. It differs from the ordinary enamels or paints in that it is entirely inorganic. Consisting of glass fused on metal at 750° to 850° C. it will withstand much higher temperatures than paint without burning off or discolouring. It is, in general, more resistant to abrasion, weathering and chemical attack.

Raw Materials

The raw materials used in manufacturing may be divided into three main classifications, i.e. refractories, fluxes and opacifiers. To these is added at a later stage, colours, floating agents and electrolytes.

The refractories include such materials as silica, felspar and clay which contribute to the acidic part of the melt and give body to the glass. The fluxes include borax, sodium carbonate, cryolite, potassium or sodium nitrate, barium carbonate, zinc oxide, etc. which are basic in character and react with the acidic refractories to form the glass.

The opacifiers are compounds added to the glass to give it the white and opaque appearance, such as, tin oxide, antimony oxide, zirconium oxide and titanium oxide. The major opacifiers are quite refractory but some of the secondary or accessory ones such as cryolite and fluospar are fluxes. It would be impossible to deal with all the raw materials used in the manufacture of vitreous enamels but it may be interesting to discuss the major materials. Silica (SiO_2) is the most important ingredient in the ceramic industry, and silicon, next to oxygen, is the most abundant element found in nature. It occurs as quartz, flint, sand, etc., and is also present in other materials such as felspar, clay and sodium silicofluoride. Its use is to give body durability and resistance properties. It has a low coefficient of expansion and increasing the silica content of an enamel reduces its coefficient of expansion.

Felspar is the most commonly occurring material, deposits are located in Norway, Sweden, Italy, Russia, America and Canada. Cornwall stone is a felspathic rock containing felspar, quartz and also alumina in excess of the true felspar ratio. This occurs in large deposits in Cornwall, but the enamelling industry use mainly Scandinavian felspars because of the absence of free quartz and alumina. Felspar is of great importance in vitreous enamels since it introduces the silica in a form which is readily fusible. It introduces potassium in a cheap form and is the principle means of introducing alumina to the batch. The alumina is particularly desirable because of its high coefficient of expansion. The theoretical composition of the potash

felspar is K_2O, Al_2O_3, $6SiO_2$.

Clay is mainly used as a floating agent in the milling of the enamel. Enamel clays in general are fatty clays, selected for their ability to hold the finely ground enamel frit particles in water suspension so that they will spray and dip evenly. They usually have ball clay characteristics.

The Fluxes

Borax is one of the most active fluxes and principal ingredients used in enamel manufacture. It is mineral or prepared compound with the following composition: 16·3 per cent. sodium oxide; 36·5 per cent. boric oxide; and 47·2 per cent. water. Practically all sources of borax are in California. It has a low melting point and accelerates the rate at which the enamel is brought into a uniform molten state. It imparts lustre, strength and assists in obtaining deep brilliant colourings.

Dehydrated borax contains relatively no water or crystallisations having a composition of 30·8 per cent. sodium oxide and 69·2 per cent. boric oxide. The dehydrated form is gaining popularity by reason of the absence of water of crystallisation reducing fuel consumption during melting.

Sodium carbonate or soda ash is an active flux and is also a powerful agent for increasing the coefficient of expansion of enamels.

Sodium and potassium nitrate are used mainly as oxidising agents to prevent reduction of easily reducible compounds in the batch during smelting. Antimony oxide is easily reduced and if allowed to go into solution its opacifying power is lost. Potassium nitrate has similar action to sodium nitrate in the smelt although it is claimed that the potassium oxide has a beneficial effect on the subsequent fusing. It is also not deliquescent whereas sodium nitrate is, but the latter is often used by reason of the difference in cost.

Cryolite is a natural sodium fluoaluminate containing 12·8 per cent. aluminium; 32·8 per cent. sodium and 54·4 per cent. fluorine. It is a strong flux and also a secondary opacifier.

Fluospar is a crystalline mineral containing approximately 95 per cent. to 96 per cent. calcium fluoride together with small quantities of silica and calcium carbonate. As with cryolite, fluospar plays the double role

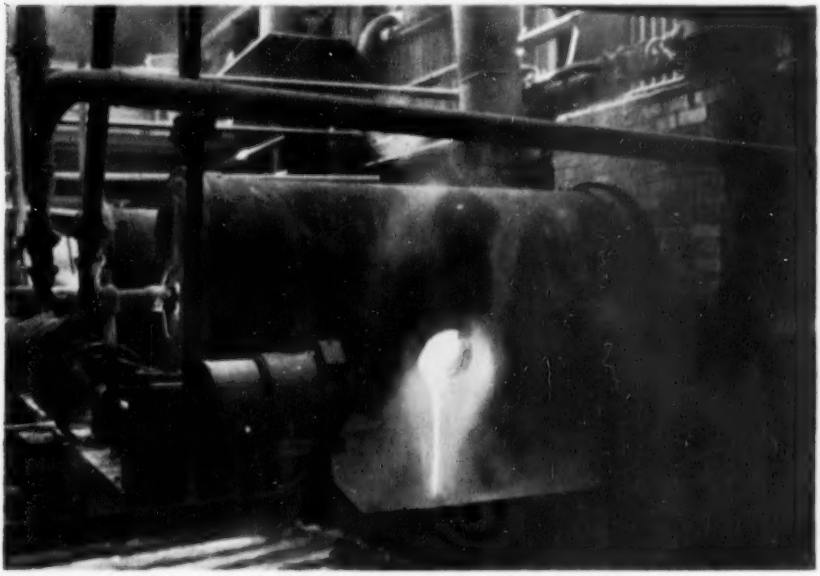


Fig. 1. Melter being emptied, and the molten glass quenched

of flux and secondary opacifier.

Zinc oxide is used mainly in cast-iron enamels although small amounts are incorporated in a number of sheet iron enamel formulations. Its specific functions are to increase fusibility, improve lustre, contribute to opacity and whiteness, reduce expansion and increase extensibility of the enamel film.

Opacifiers

Antimony oxide plays a vital part in vitreous enamels as a major opacifier. It is used in both sheet iron and cast-iron enamels and its opacifying efficiency has been increased over the years. It is, however, unusual to find antimony present in holloware enamels, because in certain forms it is toxic and cannot be used. Antimony can also be introduced in the form of sodium antimoniate.

Antimony is, however, being gradually replaced in certain enamels by zirconium and titanium oxides. I think that we may perhaps discuss the differences in these two types of opacifiers. Tin oxide and antimony oxide depend mainly on the insolubility of these materials in the glass. In the old days white enamels were made without antimony and were called "cryolite whites." They depended upon fluorine to give that opacity. They were milled with tin oxide and when we discuss milling this point will be clarified. Antimony oxide was introduced to give increased opacity and as formulations improved so the antimony opacified frits developed greater opacity.

About 20 years ago titanium oxide began to be used in enamels mainly for its acid resistance promoting properties without increasing the fusibility of the enamel. In the old days if a highly resistant enamel was required the only thing one could do was to increase the silicon content of the enamel which meant an increase in fusing temperature. It also created more difficulties in the enamelling process, but by using titanium one could add amounts of titanium to the silica without increasing fusibility and, at the same time, increase its resistance to chemical attack. In 1942 it was found that titanium in certain formulations had an opacifying property. The titanium oxide is dissolved during smelting but recry-

Fig. 2. Showing a typical pickling plant, embracing acid tanks, water rinse tanks, with constant running water to remove excess acid

Fig. 3. Illustration showing open annealing furnace

stallises out of the enamel during fusing, forming a precipitate which gives exceptionally high opacity. Zirconium oxide functioned in the same way but with totally different compositions. There is a major difference between those two types of opacifiers, one depending on insolubility and the other on recrystallisation.

Zirconium oxide is an exceptionally good opacifier in a properly balanced frit. Certain other constituents are however necessary to the production of zirconium opacity. If we go back and consider the cryolite whites or enamels which depended on secondary opacifiers, an enamel was obtained with a fairly high degree of reflectivity and opacity probably with a total thickness of 0·030. With antimony enamels that probably came down to 0·023, and then with further developments of antimony enamels it was possible to get better reflectivity and higher opacity with a thickness of something like 0·018.

With the new type titanium enamels a high degree of opacity can be obtained with a total enamel thickness of ·008 to ·010. This lends itself to the production of one coat white enamel on ground coat, reduces the thickness of the enamel and thereby improves it in respect to resistance to chipping.

Adherence

Cobalt oxide is used as a colouring medium for cover coat enamels. Its most important role in the enamelling industry is to promote adherence between the steel and the enamel coating. It is always a source of wonder to the uninitiated that a dark coloured ground coat is invariably used to produce a white enamelled sheet.

One of the chief essentials of a sheet iron ground coat enamel is to give the proper adherence of the enamel to the metal and this property is very largely governed by the cobalt oxide content. Owing to the relatively high cost of cobalt, it is common practice to replace part of this with the cheaper nickel and manganese oxides. The cobalt oxide cannot, however, be entirely replaced without reducing the adherence of the enamel to the metal.

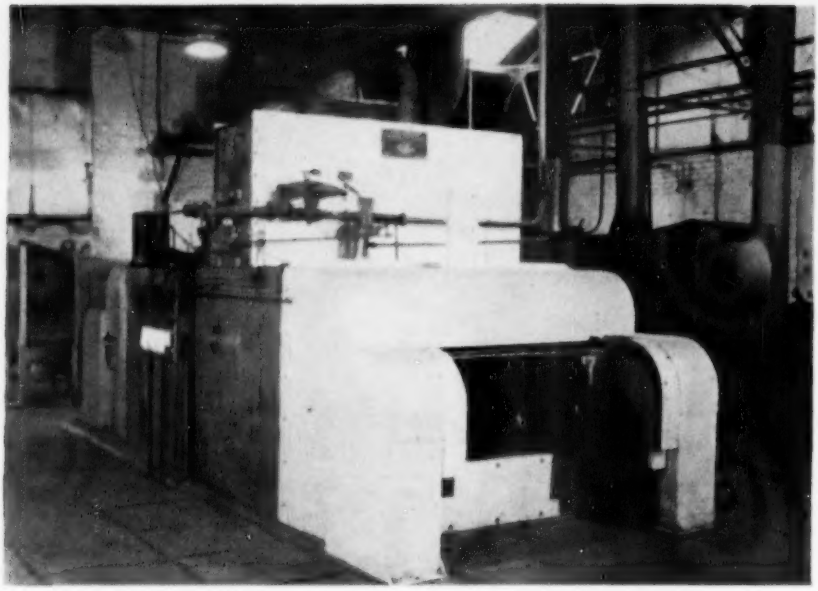


Fig 4. Inlet of a conveyor type dryer, installed for certain types of holloware

Quite a number of theories have been advanced as to the function of cobalt oxide in ground coat enamels, but none have been accepted as being entirely satisfactory. Grunwold said that the coefficient of expansion of the enamel was brought close to that of iron by the addition of cobalt and other metallic oxides. Mayer and Havas suggested that cobalt silicate is formed with the evolution of oxygen. This reaction was believed to clean the iron, making possible the intimate contact between the enamel and the iron. Tostman suggested the cobalt steel alloy theory, namely, that the cobalt oxide is reduced to cobalt which alloys with the iron. The enamel was believed to adhere tenaciously to this alloy. R. M. King believes that adherence is related to the formation of metallic dendrites which from X-ray investigations appear to be alpha iron. These dendrites form a layer between the enamel and the iron, sometimes projecting quite far into the enamel layer. In this manner they aid the adherence. It was shown that enamels which adhere have this dendritic formation and those which do not adhere have not. Whatever the explanation of the phenomenon is, nevertheless small amounts of cobalt oxide produce good adherence and a lack of it gives unsatisfactory results. To digress for one moment, it is possible with certain steels to eliminate the ground coat enamel, to do without cobalt and get reasonably good adherence; but that is a new development and is not in actual production in this country.

Composition

The composition of an enamel varies considerably according to the metal to which it is applied and to the finish required. Jewellery enamels must have a bright rich colour. They must be capable of comparatively easy polishing and must fuse at low temperatures with high fluidity and gloss.

Bath and sanitary ware enamels should have a high degree of alkali resistance to withstand the action of bath salts, etc. Enamelled signs require to be weather resisting. Enamels for certain kitchen equipment must withstand the effect of culinary acids and enamels for holloware must be free from injurious

TABLE 1.

Frit Constituents	*Chemical Formula*	*Raw Materials*
Silica	SiO_2	Quartz, Sand, Felspar
Alumina	Al_2O_3	China Clay, Felspar, Cryolite
Boric Acid	B_2O_3	Borax, Boric Acid
Potassium Oxide	K_2O	Potassium Carbonate, Potassium Nitrate, Felspar
Sodium Oxide	Na_2O	Sodium Carbonate, Sodium Nitrate, Felspar
Fluorine	F_2	Cryolite, Fluorspar, Sodium Silicofluoride
Barium Oxide	BaO	Barium Carbonate
Calcium Oxide	CaO	Limestone, Calcium Carbonate, Fluorspar
Magnesia	MgO	Magnesium Carbonate
Cobalt Oxide	Co_3O_4	Cobalt Oxide
Manganese Dioxide	MnO_2	Managanese Dioxide
Nickel Oxide	NiO	Nickel Oxide
Zinc Oxide	ZnO	Zinc Oxide
Antimony Oxide	Sb_2O_3	Antimony Oxide, Sodium Antimonate
Titania	TiO_2	Titania, Sodium Titanium Silicate
Zirconia	ZrO_2	Zirconia, Zirconium Silicate

materials and must have a high thermal shock resistance. The co-efficient of expansion of the enamel must bear a relation to the co-efficient of expansion of the metal.

The composition of most enamels is complicated by the number of elements which it contains. It is formed by the fusion of a number of raw materials and the reaction of the various elements during the fusion process. The analysis does not, in itself, give all the information necessary to produce a satisfactory enamel. I often liken it to a crossword puzzle in which the analysis gives the clues and the elements in the various raw materials are the alternatives. It is at the same time, rather interesting to note that elements exhibiting the same function in an enamel occupy neighbouring positions in the periodic classification which does help the chemist in the compounding of enamel formulæ. Cobalt and nickel which give adherence to sheet iron ground coat occur together with iron in the periodic table. Potassium and sodium which are almost interchangeable in some enamels occur together. Aluminium occurs between the bases and silica, a position which it holds in the enamels themselves. Magnesium, calcium, strontium and barium occur in the same group near sodium and potassium, and they react similarly in an enamel. Tin, antimony and zirconium are closely associated in the table and in enamels they are again grouped together as opacifiers.

Table I shows the frit constituents, chemical formulæ and raw materials from which they are derived. From that it will be seen that there is

TABLE 2. RAW BATCH.

	Jewellery Enamel	*Sheet Iron Ground Coat*	*Sheet Iron White Cover Coat*	*Sheet Iron Titanium*	*Sheet Iron Zirconium*	*Dry Process Cast Iron*	*Wet Process Cast Iron*
Borax	8·2	33·6	26·4	24·4	26·0	19·0	30·0
Quartz	18·7	20·0	20·0	26·2	8·9		17·0
Potassium Nitrate	35·5			3·4	2·2		
Red Lead	37·5						
Felspar		28·3	33·3	24·8	27·8	32·0	25·7
Sodium Nitrate		4·8	4·5			2·5	5·0
Fluorspar		4·0	4·5		7·0		7·6
Cobalt		0·5					
Manganese Dioxide		1·5					
Nickel Oxide		0·5					
Soda Ash		6·0	4·0				4·4
Cryolite			10·5	5·9	3·5	10·5	
Zinc Oxide				4·7	4·7	9·0	7·0
Boric Acid						19·5	
Tin Oxide						7·0	
Barium Carbonate				1·3	3·3		8·6
Titania				9·5			
Milled Zircon					12·6		
Aluminium Hydroxide					4·0		

difficulty in assessing the analysis in terms of enamel and in finding the right raw materials to introduce into the enamel to give a correspondingly similar analysis. That is the development chemist's difficulty. Having completed the analysis of enamel, he has to find the correct raw materials to use to give not only an analysis similar to the one which he has made, but an enamel with the same working and physical properties.

Table 2 shows the raw batch constituents or, what is commonly known as the enamel formulæ.

Table 3 illustrates frit composition or analysis of the frit. One can see that the difference between the various enamels are more pronounced. Sheet iron ground coat is shown with 51 per cent. of silica, whereas the dry process, cast-iron enamel has only 27·4 per cent. silica. You will notice the absence of zinc oxide in ground coat. Sheet iron cover coat is one of the fluorine opacified enamels.

TABLE 3. FRIT COMPOSITION

	Jewellery Enamel	*Sheet Iron Ground Coat*	*Sheet Iron Cover Coat*	*Sheet Iron Titanium*	*Sheet Iron Zirconium*	*Dry Process Cast Iron*	*Wet Process Cast Iron*
Sodium Oxide	1·80	13·95	14·60	7·95	7·18	11·12	10·90
Potassium Oxide	17·70	3·30	3·59	5·10	4·88	3·49	2·72
Boric Oxide	6·02	15·90	10·91	10·19	11·01	21·76	12·96
Alumina		6·50	9·73	7·01	10·15	10·00	5·40
Silica	25·4	51·60	49·22	48·90	37·06	27·40	41·45
Fluorine		2·00	8·76	3·65	5·96	6·93	4·06
Calcium Oxide		3·08	3·48		5·53		6·16
Barium Oxide				0·98	3·03		7·89
Zinc Oxide				5·37	5·50	10·92	8·26
Lead Oxide	69·7	0·64					
Managanese Oxide		1·94					
Nickel Oxide		0·65					
Tin Oxide						8·49	
Titanium Oxide				10·85			
Zirconium Oxide					9·70		

Enamel Manufacture

We come now to enamel manufacture and the necessity for fritting. The enamel which is received by enamel works is called "frit" and there are several reasons for fritting.

In the first place some of the chief ingredients are soluble in water, and if a mixture of the various raw materials were ground with water and applied as an enamel, the soluble salts would rise to the surface of the enamel during drying thereby reducing the fusibility of the remainder of the enamel and spoiling the fused surface. Further, some of the most important constituents of an enamel lose a considerable proportion of their weight in the form of volatile gases when being converted into an enamel and if this expulsion of gases occurred during the brief period in which an enamel is fused on to the metal, time would not permit of the interaction between the materials and would not proceed far enough to produce a glass free from gas bubbles.

Weighing and Mixing

The raw materials comprising the batch are carefully weighed out and thoroughly mixed. Modern mixers are large cylinders similar to concrete mixers, hexagonal cylinders or horizontal mixers. The horizontal type is generally trough shape, containing a revolving shaft on which are mounted paddles or spirals to mix the materials.

A typical raw material mixer is fed from the hopper at the top and discharged from the centre underneath. There is a shaft running through the centre with suitable gears on which spirals are mounted. It is allowed to run for 25 minutes in order thoroughly to mix the ingredients.

The complete mixing of the batch is very important. Since the batch is made up of refractories and fluxes the speed of reaction during smelting is dependent on a uniform mixture, and since the rate of reaction is directly proportional to the surface contact, the more intimate the mixing the more surfaces of contact exist between the particles of the flux and refractories.

Smelting

Smelting involves the melting together of the raw materials entering the enamel composition until a fairly uniform glass is formed, the temperature required being 1,050° to 1,250°

C. The physical and chemical changes taking place in the smelting of enamels are quite complicated. The fundamental changes are however, the interaction of the acids and bases, decomposition, fusion and solution. The exact nature and order of these changes, however, depend upon several conditions, such as, temperature, the combination of the raw materials and the agitation. That does not mean mechanical agitation, but agitation caused by the escape of volatile gases. Quite often a furnace is used containing perhaps six, eight or more crucibles which are heated, emptied, and then quenched. If however, it is a small batch of expensive material, it would be melted in individual crucibles in a small crucible furnace.

Quantity Production

Where large quantity production is required specially designed smelting furnaces are used. There are several types of smelters in use but the two most popular ones are the tank and rotary types.

The tank type of furnace is of simple construction and consists essentially of a refractory box or tank with the bottom sloping to a point on one side, or in the centre, wherever the tapping hole is situated. They can be fired by coal, oil or gas, the flames and flue gases passing over the enamel batch and radiated from the crown of the furnace. The batch is charged through a hole in the crown of the furnace and is levelled out by means of a rake or rod through a port hole in the side.

The rotary type furnace consists of a steel cylinder bolted on to cast-iron end plates machined on the flanges which ride on four flanged wheels, these being rotated by an electric motor. The drum is lined with high-grade firebrick. This type of furnace is oil or gas fired.

Raw materials after mixing are contained in the hopper which is fed into the melter. When the volume decreases and the material becomes tacky, the melter is allowed to revolve which more intimately mixes the materials.

Fig. 1 shows the melter being emptied and the molten glass being quenched. The principal object of quenching is to facilitate grinding. If the molten glass were cooled slowly hard lumps would be formed which would be difficult to crush or to grind. By falling into cold water the glass is shattered into small pieces which grind comparatively easily.

Continuous types of smelter have been developed in which the raw materials, after being mixed, are fed into hoppers and from there are passed into the furnace by a specially designed feeder mechanism. Inside the furnace is a sloping bank on to which the materials fall. As the mixture melts so it runs down the bank and down the floor of the furnace. Auxiliary burners are on the sides of the furnace so that careful control of temperature can be regulated. The molten frit is quenched with high pressure water after which it falls into the quench tank. It is then taken from this tank by means of carriers into the rotary dryer through which it passes. The frit is dried by means of towns gas and it then falls on to the inspection table where any faulty ingredients can be removed. It is then taken by suction into a hopper and fed into bags or other containers ready for dispatch or use.

(To be continued)

"DELANIUM" CARBON PRODUCTS

POWELL DUFFRYN CARBON PRODUCTS LTD., Springfield Road, Hayes, Middlesex, have developed a range of "Delanium" carbon products. This material is claimed to possess exceptional properties of mechanical strength, corrosion resistance, refractoriness and controllable thermal conductivity. Typical uses are for heat exchangers, the packing for absorption, scrubbing, distillation and cooling towers, where corrosive agents are encountered and as "Delanium" tiles for the construction of pickling tanks, reaction chambers and so on where resistance to corrosion is of primary consideration.

T. Watson.—Mr. T. Watson, Sales Director of General Refractories Ltd., of Sheffield, was elected president of the Silica and Moulding Sands Association at the annual general meeting of members of the Association, held in London on 20th April, 1950.

Increased Efficiencies and Reduced Fuel Cost

Through Scale Elimination and Scavenging in Boilers

by

A. WILLIAMS-GARDNER, B.Sc.Tech.

EVERY pottery engineer is only too familiar with the recurrent troubles associated with the need for boiler shut-downs to clean out accumulated sludge and scale, while every pottery owner or manager realises the cost in labour and fuel which results from boiler inefficiency and consequent maintenance work. By one means or another it has always been necessary to deal with the loss of efficiency caused by the formation of sludge and scale resulting from water hardness. When it is realised that ⅛ in. thick boiler scale increases fuel consumption by as much as 10 per cent. with a corresponding loss in efficiency of steam raising the magnitude of the benefits obtained through the adoption of sound water softening methods become apparent.

A common method of controlling the deposition of scale to some extent after introducing more or less expensive water-softening compounds, is the practice of periodic (and often frequent) "blowing-down" of the boiler. This is most wasteful of hot water and in any event only removes sludge which has accumulated near the blow-down valve. With a boiler pressure of 200 lb. per sq. in. every 100 gallons of water blown down is practically the equivalent of wasting 50 lb. of good costly coal, not to mention the loss of the water itself and its content of excess softening compound. Moreover, this method in no way reduces

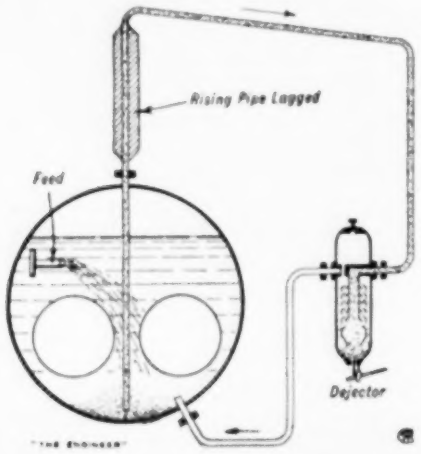


Fig. 1 Operation details by B.B.A. dejector

the quantity of sludge and scale which invariably accumulates in parts of the boiler distant from the blow-down valve. Scale formation requires frequent shutting-down, opening-up and costly chipping of the internal parts, some of which, not being readily accessible, become neglected, give rise to over-heating, and ultimately bring about mechanical breakdown.

Proven Method

A most ingenious and yet simple and inexpensive system which has proved itself in many hundreds of installations is that employing the temperature existing in the boiler, the "temporary" hardness is immediately precipitated and settles towards the lower parts of the boiler.

Water in this section of the boiler together with suspended sludge is automatically and continuously removed through thermo - syphonic action by way of a "riser" pipe rising through the top of the boiler and leading thence to the B.B.A. Dejector which is a small appliance completely self-contained and usually weighing about 4 cwt. Still through thermo-syphonic action the water passes through the B.B.A. Dejector and

Fig. 2. B.B.A. dejectors fitted to six Lancashire boilers

B.B.A. Dejector Boiler Scavenger and Water Softener, a product of British Boiler Accessories Ltd., of 62-63 Fenchurch Street, London, E.C.3. The operation of this B.B.A. Dejector is shown in Fig. 1, while Fig. 2 is an illustration of a typical application to a Lancashire Boiler installation. The process of water softening is made to take place in the boiler itself at the temperature of the water in the boiler which ensures completion of both "temporary" and "permanent" hardness removal while at the same time removing old established scale which may exist in the boiler.

Feed water enters the boiler in an untreated state, when, by virtue of the enters the base of the boiler. During its passage through the B.B.A. Dejector, water-softening re-agent is introduced in measured quantity, controlled by a needle valve into the now clean suspension-free water.

Multiple Filter Principle

The B.B.A. Dejector is designed on the principle of the multiple filter giving tortuous path to the water circulating though it. The filtering baffles separate out the sludge from suspension and precipitate it to the bottom of the apparatus. As the purified water leaves the B.B.A. Dejector it picks up the softening re-agent from the upper part in

solution and conveys it to the boiler. This re-agent is usually soda ash only, although a special chemical can be used where technically desirable by virtue of the composition of the water hardness, and, with the assistance of the temperature within the boiler, converts scale forming salts into loose sludge. This separates out and the whole process of thermo-syphonic circulation and sludge precipitation is repeated. The process is, therefore, from start to finish continuous and the only "blow-down" of sludge called for is the periodic removal of very small quantities of boiling water from the base of the B.B.A. Dejector.

The apparatus appears to have proved itself in practice on all sizes of boiler as a simple, practical and inexpensive solution for the control of scale and sludge formation in boilers, and the makers claim with ample proof, that it ensures not only permanent cleanliness of boiler interiors without the pre-treatment of feed water and the use of expensive boiler compounds, but also is capable of thoroughly scouring already badly scaled boilers. It can, of course, be used in conjunction with, or in addition too, existing water - softening equipment with considerable advantage in the form of a corrective adjunct using sodium triphosphate and as a sludge extractor for removing the precipitations from residual hardness.

MIXTURES OF PORTLAND AND HIGH ALUMINA CEMENTS

THE February meeting of the Road and Building Materials Section of the Society of Chemical Industry was held in the lecture hall of the Institution of Structural Engineers. Mr. J. C. Warr, vice-chairman of the Group, presided, and Dr. T. D. Robson read a paper entitled, "The Characteristics and Applications of Mixtures of Portland and High-Alumina Cements."

In the introduction to his paper, Dr. Robson said that the use of mixtures of Portland cement and high-alumina cement was discouraged by cement manufacturers in any situation where permanence or chemical resistance is required. Yet, because of the possibility of controlling the setting time, some users were willing to incur all the risks and disadvantages that follow the use of mixtures. He hoped that the work described in the paper would convince users that these mixtures should be used only when there is no alternative available.

The special property of mixtures of Portland cement with high-alumina cement which attracts attention is that any setting time between the normal set of the original cement and an instantaneous set can be produced by judicious addition of the other cement. A particular setting time can usually be obtained in two ways: (a) With Portland cement as the minor constituent, and (b) with high-alumina cement as the minor constituent.

The reduction in setting time brought about by adding increasing proportions of high-alumina cement to Portland cement is a much more gradual process than when the reverse addition is made. The type of set obtained varies with the mixture and the whole process is very complicated. Consequently, although the characteristics of the individual cements may be known it is difficult, if not impossible, without actual trial to predict the behaviour of any two representative batches of cement when mixed, gauged and allowed to set.

The paper included tables showing the compressive strengths of mixtures made and stored under various conditions. In conclusion, the author gave some examples of circumstances in which the use of these mixtures might be tolerated.

Discussion

There was an animated discussion which centred very much round the question of whether or not these cement mixtures should be used or recommended for use in any circumstances whatever. Mr. J. Singleton-Green said that he was afraid Dr. Robson's paper might lead some people to think that it was permissible to use these mixtures, whereas he, personally, felt very strongly that they should never be recommended. The general opinion, which Dr. Robson endorsed, was that mixtures should be used only when a quick set was imperative and outweighed all other considerations.

A vote of thanks to the author was proposed by Mr. A. W. Jarman.

(*Chemistry & Industry*, 8th April, 1950.)

Glazing Ceramic Tiles

FROM a well-known local firm of faience and tile manufacturers came an enquiry for information concerning the possibility of using a gas-fired furnace in the production of a special glaze on ceramic tiles. Their main interest, it appeared, was to obtain a tile faced with a depth of metal, sprayed on after shot-blasting, to produce a finish of attractive appearance with a protective glaze, and to render the tile impervious to liquids percolating from the back. In addition, it would be required to produce such finishes in large quantities and at a reasonable cost.

Investigation

In co-operation with the Birmingham Gas Department, many experiments were carried out to determine the characteristics of various glazes under different temperatures and furnace atmospheres. This may perhaps be more clearly explained if, at this stage, I may be permitted to quote some extracts from day-to-day test reports in respect of three different glazes, each one being identified by number.

No. 14. *Fusing at* 600° *C.*

To keep this glaze clear, the fusing conditions require to be oxidising. Under strong reducing conditions opacity and brown coloration are obtained which may (on copper) give rise to a dark brown tile. This discoloration may be removed by refusing and standing in an oxidising atmosphere at temperature. The glaze is fairly readily absorbed into the biscuit of the tile.

No. 8. *Fusing at* 700° *C.*

This was not quite so susceptible to reducing conditions and not so readily absorbed into the biscuit.

No. 29A

This flux required a neutral or slightly oxidising atmosphere.

The furnace used for the fusing tests was an incandescent heat open-type oven furnace, regulated by the gas supply and the damper to a suitable temperature (generally about 750° C.) and the atmosphere either oxidising or reducing as required. The door was slightly raised and bricked up to give a small working space to the furnace proper or a small forehearth for either preheating or cooling.

1st Series Tiles 1 *to* 6 *(all copper)*

Tiles 1 and 2 were glazed with No. 14 flux under slightly oxidising conditions (CO_2 = 13·0 per cent.; O_2 = 1·2 per cent.). They indicated a clear glaze very easily absorbed into the biscuit. The metallic coatings on polishing were found to be inadequately glazed.

Tiles 3 and 6 were glazed with No.

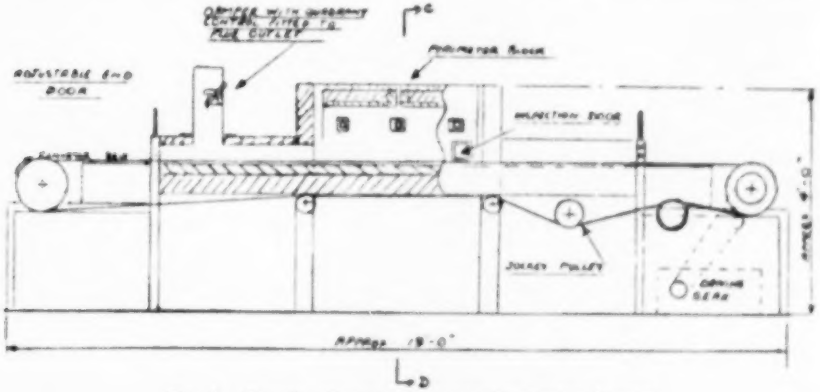


Fig. 1. Details of conveyor-type tile glazing furnace

14 flux under slightly reducing conditions and though they gave attractive results of copper relieved by pools of glaze, they were found on polishing not to have sufficient glaze.

Tiles 4 and 5 were glazed with No. 8 flux, a single sprayed coat with No. 4 and a double spray with No. 5. No. 5, on polishing, gives an almost suitable result.

Test Conclusions

Of the glazes used, No. 8 seems to be the most promising and various pleasing effects can be obtained in suitable atmospheres. The process will need a furnace, preferably of the conveyor type with a working temperature of 750°-800° C., of which the atmosphere can be controlled within narrow limits about the neutral point. A suitable time of preheat, not less than about 6 min., and of cooling after fusion, will not need to be provided.

The Furnace

A conveyor-type furnace was designed and built (Figs. 1 and 2) and comprised a fusing zone 3 ft. 6 in. in length, flanked on either side with sections of similiar length for preheat and cooling. The flue outlet, being arranged at the extreme end of the preheating section, is fitted with a fully adjustable butterfly damper control. Adjustable slide doors are fitted at both ends of the furnace to allow for improved control of atmosphere conditions.

The furnace was fired by six gas/air blast "C C" type tunnel burners, each separately controlled for gas and collectively under the control of a main air supply valve from the fan outlet.

A continuous nickel/chrome chain conveyor belt travels through the furnace at a range of variable speeds. Motive power is provided by a ¼ h.p. electric motor, through suitable pulleys and reduction gear, to the belt drive.

Results

Many weeks have now passed since this furnace was installed, during which time experiments have proceeded and are still continuing with a wide range of glaze finishes.

It is perhaps ironical that, although our quest to reproduce the original metallic or "Velk" finish in quantity has so far been unsuccessful, it has led to the development of coloured lustre tiles which, we understand, are perhaps commercially more valuable than our first objective.

I feel quite confident, however, that when certain modifications to the furnace have been carried out, complete success will be our portion.

My thanks are due to our engineer and manager, Mr. J. E. Wakeford, for the provision of facilities in connection with the preparation of this paper and to my colleagues for their invaluable assistance.

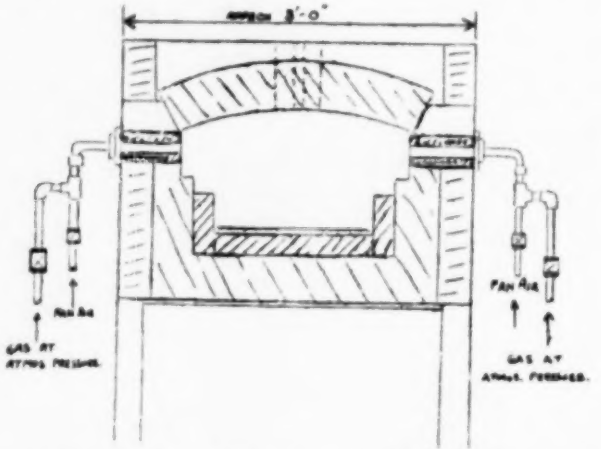


Fig. 2. Details of conveyor-type tile glazing furnace. Section through C. D on Fig. 1

Extracted from a paper by I. A. W. Stretton entitled "Industrial Problems at Coventry," presented to the Midland Junior Gas Association.

High-Temperature Combustion-Heated Furnaces

by

M. W. THRING
M.A., F.Inst.P., M.Inst.F.
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IN this paper an attempt is made to decide how far the thermal efficiency of industrial furnaces could be improved by application of existing fundamental knowledge, and in what directions more fundamental knowledge is needed. Thermal efficiency depends in the first place on employing a heating cycle that can make use of the heat in the combustion gases over the whole range from the theoretical combustion temperature to room temperature. Secondly, it depends upon the precision with which this cycle is carried out, in which importance attaches to promoting rapid combustion—high rates of heat transfer to the charge and low rates of heat transfer to the outside atmosphere through the walls.

Existing knowledge can contribute to the achievement of these aims, particularly as regards control of the combustion-gas composition, the use of models to find out how to improve mixing and so shorten flames, and the more extended use of the counter-flow heating system. The benefits which would accrue from better application of existing knowledge can best be assessed by controlled variable statistical trials planned to enable factorial analysis to be carried out. Subjects on which more knowledge is required are the emissivity of luminous flames, general conditions of mixing and the effect of recycling combustion gases; this knowledge can be obtained both by laboratory studies and by probe trials on industrial furnaces.

In the observation on actual furnaces in order to provide fundamental knowledge two types of measurements are customarily made by inserting

Abstracted from a paper presented to the Institute of Fuel, 28th March, 1950.

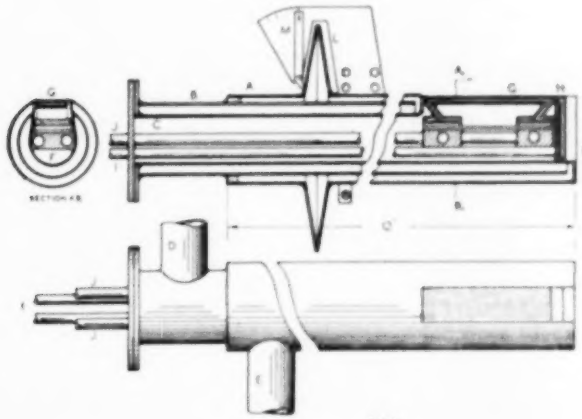

Fig. 1. Heat-flow meter

A. Outer casing. B. Water-flow separating tube. C. Inner casing. D. Water inlet. E. Water outlet. F. Water-cooled end plug. G. Calorimeter surface. H. Surface of F acting as guard ring. I. End plug water-flow tubes. J. Calorimeter water-flow tubes. L. Expansion joint in outer tube. M. Expansion indicator

probes into the furnaces. In the first, a single type of probe such as a heat-flow meter[1] or a suction pyrometer may be used to measure the distribution of heat transfer over the charge surface, or the distribution of flame temperature through the flame. Such measurements may suggest how the design may be modified so as, for example, to make the heat transfer to the charge more uniform or to shorten the flame. In the second type of measurement at least two forms of probe are used and the furnace is made to furnish data which can be used to provide fundamental knowledge. Thus, for example, if the gas temperature and flame radiation are measured along the flame its mean

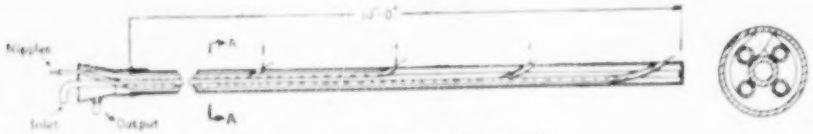

Fig. 2. Multiple gas-sampling probe.
A-A. Position of enlarged cross-section.

emissivity can be calculated and hence the emissivity can be related to the burner conditions. If the flame temperature and the degree of combustion (gas samples) are measured along the flame, the combustion rate can be related to the burner conditions; while measurements of the gas temperature and gas velocity can be used to give the flow distribution as a function of the wall shapes and the quantities of gas flowing.

Probe instruments for making the first type of measurements now include the heat-flow meter (Fig. 1), multiple gas-sampling probes to study mixing

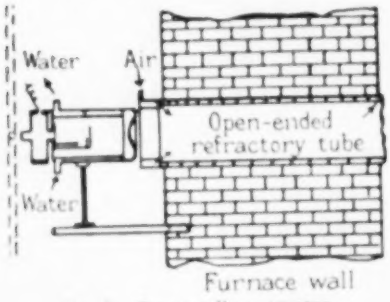

Fig. 3. Front-wall pyrometer.

(Fig. 2), wall-radiation meters (Fig. 3), narrow-angle flame-radiation meters (Fig. 4) and sensible-heat meters [2, 3]. The systematic use of pairs of these instruments for the second type of measurements is as yet in its infancy and many of the gaps in present knowledge may thereby be filled within the next few years.

Conclusions

This analysis of the present position of research into high-temperature combustion-heated furnaces indicates that interest should be about equally divided between application of existing knowledge and discovery of new. Under the category of existing knowledge which is as yet insufficiently applied, come the following:—

(1) Control of furnace waste-gas composition with, as an immediate aim, the use of CO_2 and O_2 meters to analyse the gases in the downtakes of regenerative furnaces. By making use of the information provided by these meters it is possible to eliminate air leakage, adjust the combustion air to the proper value and so secure great savings of fuel. A high-temperature furnace should be nearly gastight and not the leaky box of bricks that is still too often found in general use.

(2) The control of flame length (nearly always in the direction of shortening the flame) could be much more widely applied, using where necessary existing model techniques to evaluate the advantages of various methods of accelerating mixing.

(3) The counterflow principle, to make use of much more of the heat of the fuel in the furnace chamber itself, could be more frequently adopted in the design. Since in most cases the capital cost of a furnace is equal to the value of the fuel consumed in a few years, increased capital cost will usually be offset by the fuel saving.

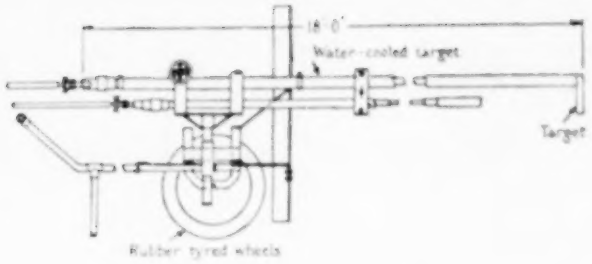

Fig. 4. Narrow angle radiometer.

Turning to the new knowledge required, the outstanding points are:—

(1) The general laws of luminous radiation in combustion systems are completely unknown, and it is therefore necessary to resort to guesswork when calculating the emissivity due to soot in the flame. Since this is often the major mechanism of heat transfer in high-temperature furnaces the importance of adding to our knowledge of the subject is clear.

(2) It would be possible to secure the much-needed knowledge of flame length by developing general formulæ for the mixing volume of various designs and the effect on this of walls, by means of a comprehensive series of model experiments.

(3) Recycling of combustion gases may prove to be an important means of improving the design of high-temperature furnaces. Its importance cannot be assessed, however, until the effect of recycling upon (i) local overheating of refractories (ii) flame emissivity (iii) temperature, has been determined.

These gaps in our fundamental knowledge are being and will be filled by a combination of laboratory experiment, probe trials on existing furnaces under steady conditions and controlled trials on existing furnaces in which conditions are deliberately altered according to a statistical design.

REFERENCES

1. Baulk, R. H., and Thring, M. W. Heat-flow Meter for Use in Furnaces. *J. Iron and Steel Inst.*, 1946, 154, 433.

2. (a) Mayorcas, R. Gas Temperature Measurement above 1,500° C., *ibid.*, 1949, 22, 251 to 255.
(b) Mayorcas, R., Pritchard, W., and Thring, M. W. The Problem of Gas Temperature Measurement above 1,550° C. (Symp. of Combustion, Flame and Explosion Phenomena, Wisconsin University, 1949.)

3. Baulk, R. *J. Inst. Fuel*, 1950, 23, 77 to 85.

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Mechanisation in a Dry Grinding Silica Brickmaking Plant

by **O. WINFIELD**

Mechanical Equipments Ltd., Leeds

Because of the extremely practical nature of this paper and the tendency towards mechanisation, we are reproducing the paper in two parts. The first part deals with the primary stages of the process and the second part will cover the secondary operations. The paper appeared originally in the Transactions of the British Ceramic Society, Vol. XLVIII, pages 323-342 and is reproduced here by kind permission of the Society and Author.

Abstract

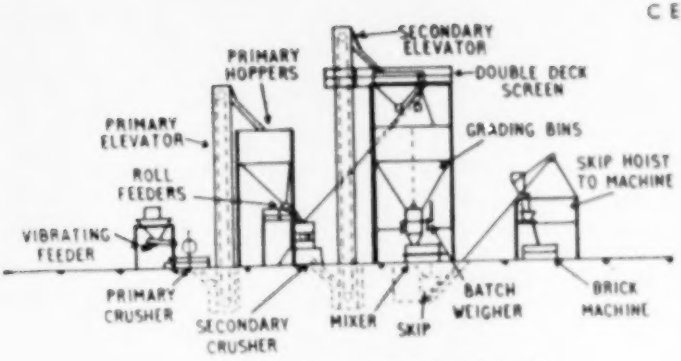
THIS paper deals with the engineering aspect of mechanical handling of all processes from washing of raw stone to the conveying of dried bricks and blocks to the kilns. From the washing stage, the stone is crushed first through a primary and then through a secondary crusher, the material being handled by continuous belt and bucket type elevators and adjustable feeders, with an intermediate storage stage. Following this, the material is screened and the graded sizes are conveyed to a range of grading bins which includes the provision of storage for super fines from the ball mill and for hydrated lime. A batch-weighing hopper runs on a track underneath the range of bins for receiving weighed quantities of the differing grades of stone required to form the batch. The mixers serving the brick machines are arranged underneath the track so that the content of the batch hopper may be discharged into the particular mixer concerned, at which stage a measured quantity of sulphite lye and water is added. From the mixers, skip hoists convey the batch to receiving hoppers feeding the brick machines. Electric lifting - platform trucks convey the bricks on stillages to dryers where tracks are laid locally to suit, and from thence the dried bricks on their stillages are again picked up and transported to the kilns for firing. Particular attention is paid in design to efficient sealing for the dust proofing of all equipment.

Introduction

The complete mechanisation of a dry process silica brickmaking plant is covered by this paper. It is not intended to compare the relative merits of the dry process and the wet grinding process. In the case of the wet process the batch contains about 9-12 per cent. of moisture, whereas the moisture content of batch for machine made bricks and shapes is about 4-5 per cent. Because of the dry and dusty conditions obtaining in the crushing and grading of stone for dry process products, plant must of necessity be dust tight—the injurious properties of silica dust are well known.

In considering the arrangement of plant to be described (Fig. 1) it will be appreciated that an ideally uniform layout is not necessarily applicable to the individual requirements of many silica brickworks. In many instances where it is desired to carry out considerable changes in a brickmaking plant, the size and shape of buildings and available floor space are not suited to a standardised arrangement. Again, for economic reasons, which are of primary importance, it might be considered policy, even on a long-term basis, to reconstruct buildings so as to comply with the height and area required for a cut-and-dried scheme.

It should be clearly understood, therefore, that in considering the merits of the mechanisation of plant in the way to be outlined, no rigid dimensional layout is intended or



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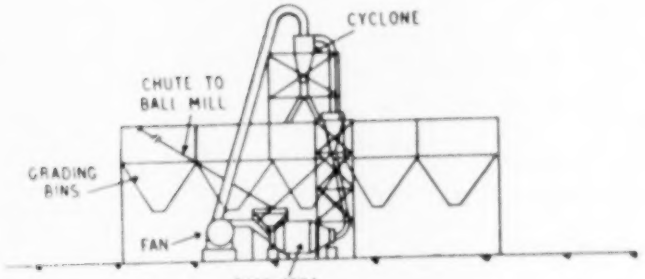

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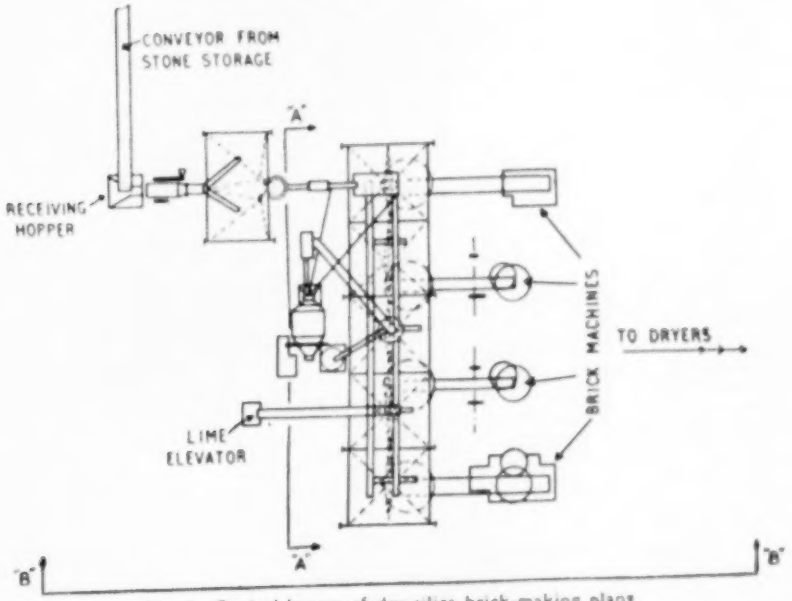
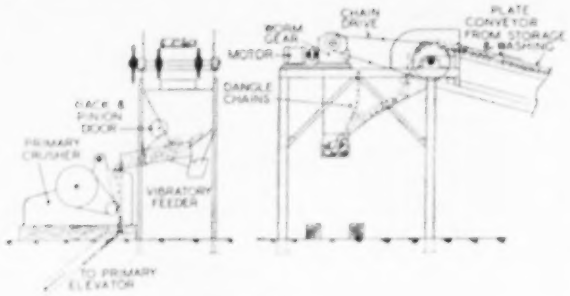


Fig. 1 Typical layout of dry silica brick-making plant



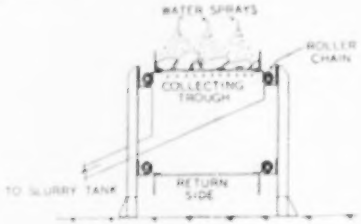


Fig 2 (a). (Top) Arrangement of primary crusher feed. (b) (Bottom) Typical section through washing conveyor

necessary. It is, of course, true that, given an open site of ample dimensions, and with suitable ground, there may be many justifiable reasons for having one section of a plant lined up with another section, particularly if unnecessary handling is to be avoided. Nevertheless, an examination of handling mechanically all the processes involved will show that the correct application of mechanised methods will accommodate changes of direction in the production line to suit most circumstances. Each handling problem is an individual matter, according to the job to be performed, and the adaption of mechanical handling methods to a part of the process, if not of an overall scheme, may well be advantageous.

Washing

Washing of the stone before it is processed may be carried out in a simple and effective manner by conveying the quarried stone on plate-type conveyors (Fig. 2a). Two separate conveyors should be used,

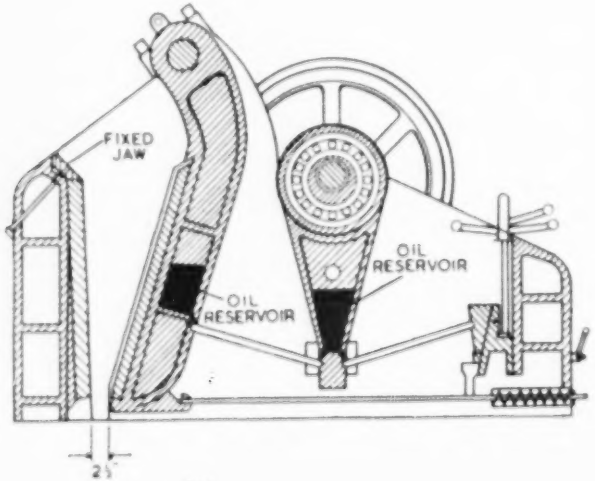


Fig. 3. Jaw crusher—Swinging jaw or "Blake" type

one feeding off the head on to a second continuing conveyor at the stage where actual washing occurs. At this point jets are fitted at regular intervals for a suitable distance, and the arrangement allows the lumps of stone to be turned over so as to wash all surfaces well. Water pressure at the jets must be at least 20 lb/sq. in. for effective washing. The conveyor plates should be perforated, and a trough should be fitted underneath the spray section to collect the effluent and drain away the water. Piping or ducting running from this trough should lead to some suitable pool or settling tanks and, if required, the water can be recirculated to the jet branch.

There are, of course, other effective methods, dependent upon local conditions and preferences, but assuming that washing is being effected at the works and not at the quarry site, the method described has at least one good point in its favour. The storage of raw stone and the washing process can be arranged at a position well away from the plant building where ground space is available and easily accessible to incoming transport, thus ensuring that messy processes are entirely separate from the main plant. The conveyor unit can be continued from the washing section direct to the primary crusher.

Should the particular stone absorb an abnormal percentage of water (more than 2 per cent.), it will be necessary to install a dryer at the end of the conveyor before the stone is delivered to the crusher. In modern practice, however, unless such a stone is particularly high in silica and very low in alumina when washed, it would hardly be considered suitable for silica brickmaking.

Primary Crusher

The most widely used type of crusher for breaking down sizeable lumps of all types of hard stone is the swinging jaw or "Blake" type of breaker (Fig. 3). This is a primary crusher of large output, free from inherent weakness due to simplicity of design, and requiring a minimum of lubrication and maintenance; it is especially suitable for continuous heavy duty. Where, as in the present case, exceptionally hard and abrasive material is being crushed, it is essential that the jawstock and side plates should be made of a metal which has good wear resisting characteristics. Suppose that the average size of stone as received at the works is approximately a 12 in. cube, then the suitable

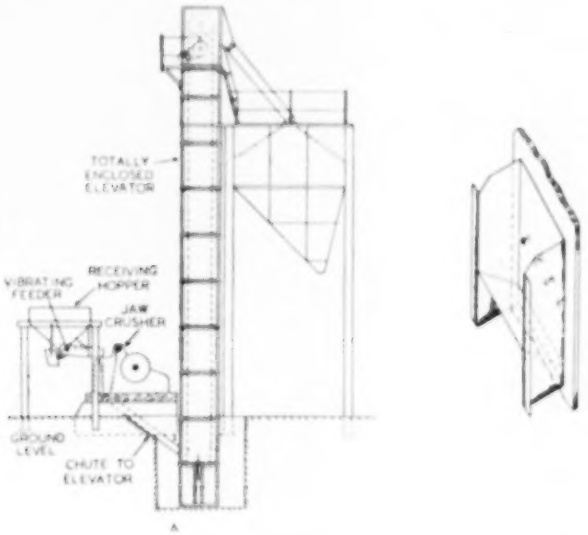


Fig. 4 (a). General elevation. (b) Continuous overlapping bucket

size of machine to be selected will be 24 in. × 13 in. giving an output of 20 ton per hour, consisting of approximately 90 per cent.—2½ in. and 10 per cent. 2½-3 in. material. Capacity can of course be increased, if required, by adjusting the discharge opening. To give an example, for a crusher of the type and size selected, with the jaw setting of 2½ in. the maximum capacity will be 25-35 ton. If, however, the setting is increased to 4 in. an output of 30-40 ton per hour will be obtained.

Receiving Hopper

As previously mentioned, the typified arrangement allows for the washing conveyor to deliver stone to the primary crusher. It is necessary, therefore, to have a receiving hopper (Fig. 2b) not necessarily of large capacity, adjacent to the crusher, to take the material from the conveyor delivery chute. This hopper should be strong and reinforced to withstand wear caused by abrasion and also the continual impact of large heavy pieces of rock. It must also be provided with an outlet of sufficient dimensions to avoid jamming, which is a matter for special attention in design. From the hopper mouth a short feeded, operated at a controlled rate, will deliver the stone into the mouth of the crusher. This feeder may be any of the electrically vibrated types, of which there are many suitable makes, but it must be essentially of strong construction, adaptable to the heavy conditions of duty.

Primary Elevator

A continuous belt and bucket elevator should be used (Fig. 4a); this type has proved most suitable for handling abrasive silica raw material, and experience has shown that wear on the belt is quite small. Buckets of the overlapping type, which are usually of welded mild steel (Fig. 4b), are used to prevent spillage and consequent "dredging" in the bottom of the boot which, if occurring to any appreciable extent with this material, would be very serious. While it is generally acknowledged that the use of belt conveyors for this type of work is the best practice, much floor space is needed—an obvious disadvantage in many cases.

The elevator under consideration will have a nominal capacity of 20 ton per hour and must be totally enclosed in a mild steel casing of close riveted and bolted sections, with all joints sealed against dust. Under ideal working conditions, the elevator should give 30 or more ton per hour, as extra depth of bucket is required for the primary elevator in order to accommodate any long, narrow and thin pieces which may pass through the crusher jaws. The buckets should be dimpled at the fixing holes to allow fastening to the belt by a special type of elevator bucket bolt with dished washers, and they should be flanged

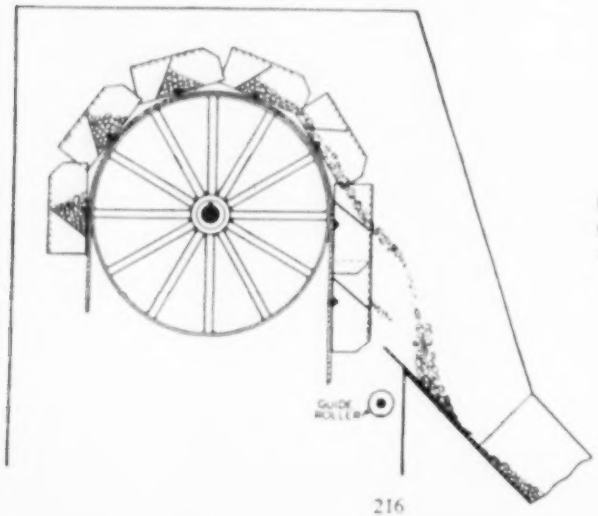


Fig. 5. Section through head of continuous bucket type of elevator

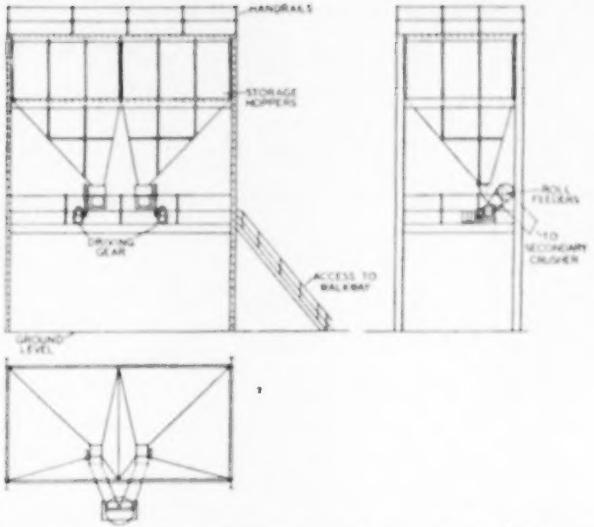


Fig. 6. Arrangement of primary storage hoppers

on the outer edges to provide a flat running surface for the guide rollers. The feed hopper on the boot casing should be positioned to give easy feed at the correct angle (approximately 35°), so that the feed point on entry to the casing allows for adequate distance from this point to centre line of the tailshaft.

The tailshaft is housed in adjustable tension gear, the simplest and most efficient type probably being of cast-iron blocks on the outside of the boot casing, and running in angle guides on the casing with a long screw device for adjusting the tension of the belt. With little trouble, this type can be constructed so as to form a dust-proof fitting. The size and width of the casing is, of course, decided by the size of the head and tail pulleys required, width of bucket and allowance for clearance. If guide rollers are used, those on the outside of the buckets make even more clearance necessary. The best practice with guide rollers, in the case of vertical elevators of this type, is to arrange them in pairs, running on the outside flanges of the buckets about every 10 ft. with a roller on the inside surface of the belt on the full-bucket side, just above the feed point to ensure true line of travel and correct position of the bucket as they are filled.

It is essential to use a belt of suitable ply, bearing in mind that the thicker the belt, the larger the size of pulley required, with a corresponding increase in the size of the casing. Elevator belts for this purpose should have at least $\frac{1}{16}$ in. rubber covering on each side, it being found in practice that, unlike conveyor belts, both sides get equal wear.

The point of delivery at the lower edge of the casing orifice in relation to the head pulley is decided by practice to ensure correct trajectory of the material from the head of the elevator (Fig. 5). This is particularly so with vertical elevators, where there is no initial inclination of the line of throw from the buckets as they pass over the head drum. As with the elevator feed hopper, the delivery chute must also be designed at the correct angle for easy flow of the material; since we are dealing with silica stone, the bottom plate, like that of the feed hopper, should be provided with a replaceable liner plate. Side liners should also be provided for about 6-9 in. from the bottom of these and all chutes handling raw stone.

Primary Hoppers

One important factor in the design of a mechanical handling plant of this nature is the facility afforded by arranging bunker storage at suitable positions in the plant process. By so doing loss of production due to some temporary stoppage is avoided for a period, in that storage may be drawn

upon to the capacity of the bunker or bunkers, for the succeeding part of the plant. On this account, provision should be made for the primary elevator to deliver primarily crushed stone into bunkers instead of feeding it direct to the secondary crusher. It is advisable to make the primary storage capacity of this stone equal to one day's supply, say 100 ton, so that if any stoppage occurs in the supply of raw stone, or if any repairs are required to this first section of the plant, production need not be affected for some 8 hours—by which time no doubt, any minor troubles will have been rectified.

A single bunker of 100 ton capacity of silica stone would create structural difficulties. These may be overcome by having two 50 ton bunkers combined. This also allows two stones to be blended while being fed to the secondary crusher, the rotary feeders for each stone being adjusted to give correct proportions. The design of the bunkers provides for the juxtaposition of the outlets in the manner illustrated in Fig. 6. By this method, unnecessary lengthening of the two feeder chutes to the secondary crusher is avoided and consequently the headroom required for the feed above the crusher is kept to a minimum. In construction, the usual fundamental principles of bunker design will apply; the inside surfaces must be kept even and free from bolt or rivet head projections, and the valley angle formed between any two sloping surfaces in different planes must be consistent with the inclination required for free flow of the material.

(To be continued)

General Refractories Ltd.—We have received a complete series of catalogues and brochures from General Refractories Ltd., Genefax House, Sheffield 10, and the following titles are included here as readers may wish to obtain these:

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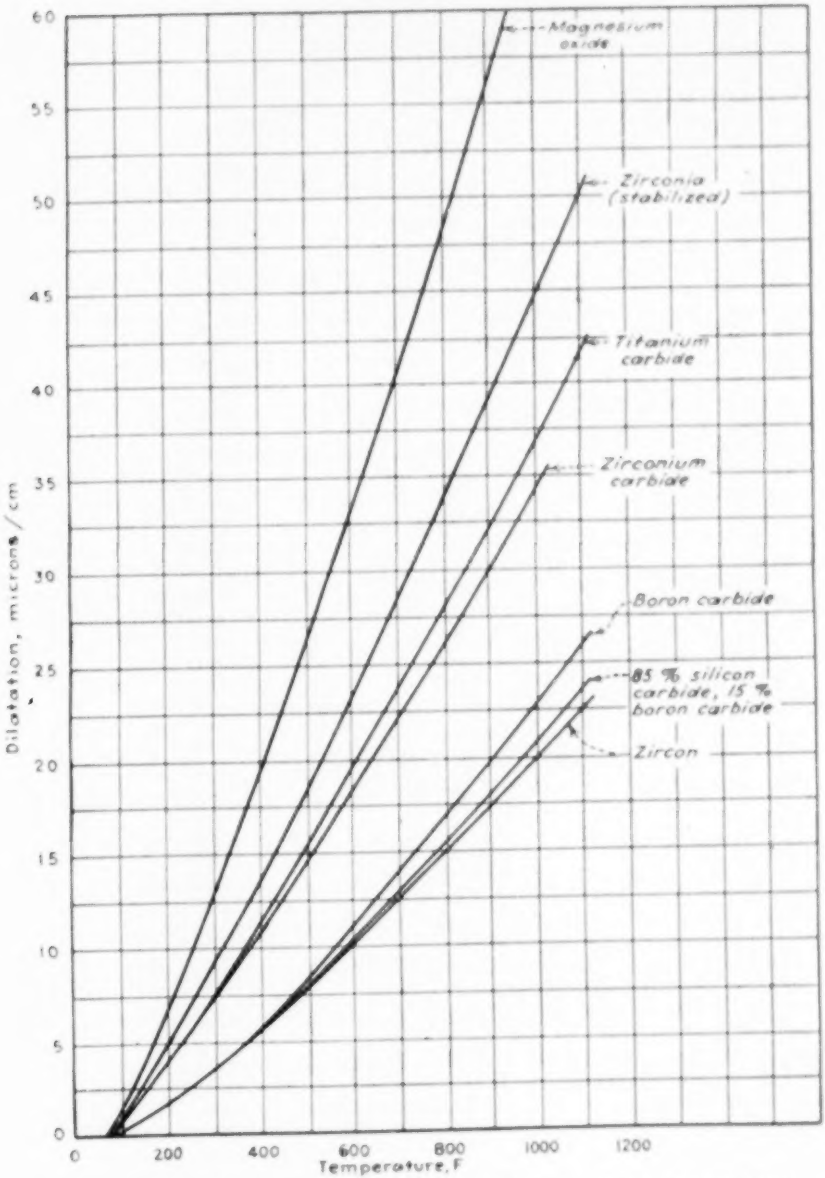


Data taken from "Physical Properties at Elevated Temperatures of Seven Hot-Pressed Ceramics" by Gangler, Robards and McNutt, American National Advisory Committee for Aeronautics

Refractories in Galvanizing Furnaces

A STAFF REPORT

BASICALLY, the equipment used today in galvanizing is the same as that employed when the process was first devised in the early 19th Century. In other words, the zinc bath is still contained in a steel kettle and heated, via the walls of the kettle by some external heat source, be it coke, gas, oil or electric resistance elements.

The fundamental fault in this practice lies in the fact that the kettle is subjected to gradual dissolution by the molten zinc, giving rise to two acute disadvantages:—

1. Kettles require constant renewal.
2. Extra dross is thus formed (each lb. of iron dissolved produces 25 lb. of dross).

This attack by the zinc on the container walls imposes a serious limitation on the allowable rate of heat input for a given size of zinc bath. Were it not for this factor, much greater production could be achieved by many units.

It has long been realised that a kettle of inert refractory material would be desirable but the snag was —how to get the heat into the bath?

From the Ajax Engineering Co. of Trenton, N.J., comes news of recent developments in L.F. induction furnaces designed to supply the solution to this problem—a solution in the form of large and powerful induction galvanizing furnaces using refractory containers of essentially unlimited life.

Briefly, the equipment is as follows:

The zinc container or hearth is rectangular in shape (Fig. 1), consisting of a steel housing (e) with a refractory lining (f). An inclined duct (g) is provided in the side wall and flares out into the upper portion of the hearth. The 100 kw. induction unit is fitted to the side in such a fashion that the melting channels (k) are in line with the flared duct. Heat generated in the inductor is conveyed to the hearth via the duct using the path shown by arrows in Fig. 1. It will be observed that the duct is so positioned that little or no circulation takes place in the well of the hearth (in order to permit settling of dross).

The bath is fitted with a thermocouple (o) for the automatic control of temperature. Another good practical feature is that apart from the reason already quoted, the duct was so aligned as to permit ready cleaning with suitable tools, via the furnace top. Use of this equipment at once wipes out the possibility of interaction between the molten zinc and its container, giving rise to:—

1. Simpler and cheaper maintenance.
2. Considerable reduction in the amount of dross produced (20-30 per cent.).
3. Freedom to work the bath to its full limit and not to that imposed by the kettle life.

In addition, the low frequency inductor brings to the galvanizing process a degree of temperature control hitherto unattainable. This is brought about by the internal circulation and the avoidance of all time lags and temperature gradients inevitable in external heating practices. This closer control of temperature results in a more uniform quality of product and obviates the formation of additional quantities of dross from work-pieces hitherto caused by local overheating practically unavoidable in the externally fired kettle.

The 7 ton furnace described was powered by one 100 kw. induction unit to give the same production rate as a normal 10 ton iron kettle unit.

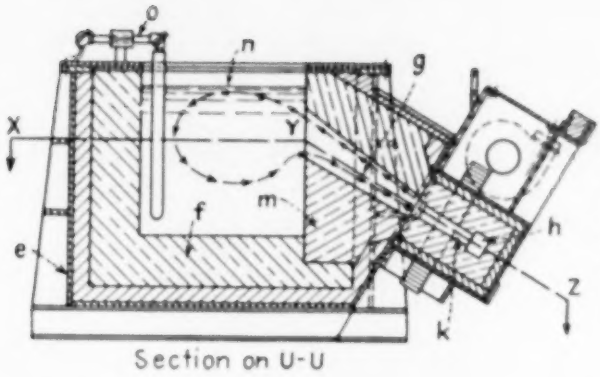
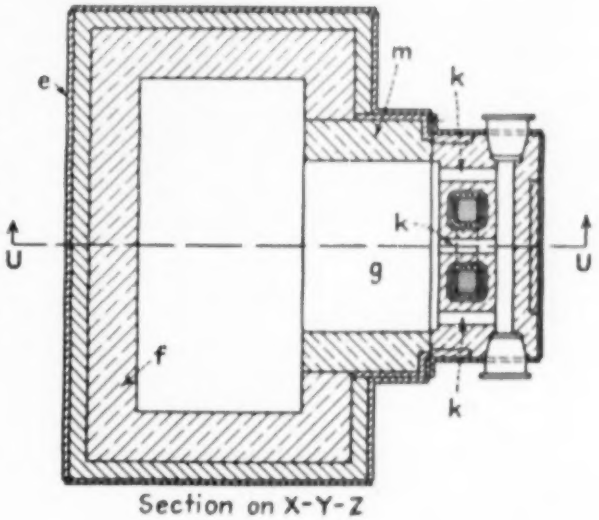


Fig. 1. Sections of a low-frequency induction furnace for galvanizing purposes. Heat is generated in the inductor unit and conveyed to the hearth by electromagnetic forces, as shown by arrows. Note the position of the inductor and channels in the upper half of the furnace wall to comply with the principle that the bottom of the hearth must not be heated so as to allow for the settling of dross



Maximum production is quoted at 1 ton/hr. of galvanized steel. It is pointed out however that the same 7 ton unit could be made to deliver two or three times its present maximum output by stepping up the power of the induction unit or adding further similar units. In this way, it is claimed that galvanizing units up to 2,000 kw. and of 20 ton/hr. output are feasible.

Further advantages are:—

(a) Comfortable working temperatures.
(b) Absence of exhaust gases and fumes.
(c) Cleanliness.

Original apprehensions as to possible adverse effects of constant circulation in the bath proved quite unfounded and, as mentioned before, this motion would appear to be responsible for an improvement in uniformity of coat. Certainly, we are told, preliminary results are so encouraging, that a wide scale adoption of the technique throughout the industry is envisaged.

(*Iron Age*, 165, 12, 93-96.)

Change of Address.—John Fyfe Ltd., granite quarry owners, granite merchants and brick makers, moved to new head offices on 22nd May at 7 Bon Accord Square, Aberdeen. Telephone number remains Aberdeen 21231.

American Production of Dresden-Type Chinaware

THE American demand for Dresden-type chinaware did not slacken with the advent of World War II, but its availability from Europe did, resulting in U.S. manufacturers first attempts to imitate the workmanship.

One firm to enter this field was Heirlooms of Tomorrow, California, who now produce Dresden-type figurines, ranging in size from 3 in. to 15 in., china lace slippers in sizes from 1 in. to 18 in., chariot slippers, vases, centre pieces and candelabra.

The finesse of detail in these products is attributed to the type of clay used, handling techniques and the method of firing. Training of employees on the job takes about one year, while approximately six tons of dry clay are used per month in the manufacture of 10,000 articles.

First step in the process is the moulding of the ware. In addition to china, ball, flint and various other clays, certain minerals are also used in moulding. The original moulds are of plaster of paris.

First, liquid porcelain is poured into the plaster of paris moulds, excess porcelain being drained, leaving a partially dried thin shell adhering to the walls of the mould, which is then opened and the model removed.

After a two- or three-hour drying period, the mould seams are removed with a tool and moist sponge. The figurine is then draped with real lace and bobbinet which have been dipped in porcelain. Draping requires a higher degree of skill than any other single operation, for it must be done rapidly or the cloth loses its pliability and will not cohere to the model. The bonnet and draped arms are added after the bodice and skirt are finished.

The decorative flowers are made petal by petal with a special process porcelain. The excess stem is then cut away and the bottom of the flower is dipped in liquid porcelain and placed in position.

Bisque Firing

Now the model is ready for the bisque firing. This is done in a 15 c. ft. semi-muffle, top loading kiln fired by six upshot burners. Temperature is gradually brought to 2,240° F. over a ten-hour period and held approximately one hour. The temperature is lowered to 1,500° F in one hour by reducing the gas input. The gas is then turned off, allowing a temperature drop, due to normal heat loss, for about ten hours. An important aim of the bisque firing is to obtain a hard porcelain base. Because of the extreme controllability of the fuel, temperatures and quality of bisque can be exactly co-ordinated for best results.

After cooling, the figurine is ready for the glaze firing. This is done in the five periodic kilns, also gas-fired. These are 20 c. ft., semi-muffle, side loading alpine kilns. Each kiln is equipped with dual burner assemblies and each of these in turn is equipped with one electric motor and two centrifugal fans. One fan supplies air to the lower or main burner. The second fan supplies air to the upper auxiliary burner. The main burner supplies premixed gas and air to the bottom front corner of the kiln and the auxiliary burner supplies the fuel mixture about half way up the combustion chamber. One burner assembly is located on each side of the kiln door. The auxiliary burners are used only during completion of firing in order to prevent local hot spots.

Eight hours are required to bring the temperature to 1,960° F. for firing of the figurine after it has been dipped in glazing compound. This temperature is held for one half-hour, then gas is turned off and the kiln is allowed to cool for twelve hours.

Colour Firing

The third firing is for colour. Special paints are applied to the

figurine's hair, eyes, trim of flowers, etc., which are then subjected to a temperature of 1,375° F., reached after four hours. The gas is again turned off and the kiln is allowed to cool for twelve hours. This final firing makes the colour permanent.

Recently installed, an Alpine fork-lift loader system has cut the number of handling operations from twelve to four.

Fork-lift Loader System

Under this new system, the dolls are placed directly on the kiln shelf by the girl who dresses the figurine. The fork-lift then picks up the entire load and sets it in the kiln. After the firing is completed, the kiln is allowed to cool to 300° F. The load is then removed by the fork-lift and is taken to the glazing department. In hand unloading, it was necessary that the kiln be cooled to 100° F. after firing. As soon as the kiln is emptied, a fresh load is placed in the kiln ready for firing, thus eliminating the cooling of the kiln during hand unloading and reloading. The speed of this operation retains the heat in the kiln and affords them an additional saving in fuel.

After glazing the ware is restacked on a second loading stand. Again the fork-lift is used to load and unload the glaze kiln and to deliver the ware to the decorators who restack their work on a fresh loading stand. The load is then taken to the decorating kiln and fired. The fourth and final handling is the unloading of the decorated ware at the stock room.

(*Gas*, U.S.A. March, 1950)

AMERICAN ADOPTION OF POTTERY MAKER

WE noted with interest that recently Mr. A. E. Hawk, president of the Hawk Laboratories Inc., was demonstrating what was described as a new rolling-jigger idea of English origin.

The use of the rotating jigger rolls the ware into shape on the mould instead of scraping the clay across the mould as is done in conventional practice, so that the processes of batting out and jiggering can be combined into one operation.

The ordinary jigger tool is a finely machined cast-iron tool approximately conical in form, shaped to the bottom of the plate. The grooved cone set at a slant to the vertical rolls freely and smoothly on roller bearings.

Among significant advantages claimed by Mr. Hawk were:

(1) Increased tool life.

(2) Virtually no adjustment time needed during production runs.

Automatic making machine, developed by Service Engineers Ltd., Stoke-on-Trent

The American machine, as demonstrated by Mr. A. E. Hawk

(3) The elimination of the practice of filing the tool, as there are no sharp edges to wear or become uneven.

(4) Fewer strains in the wear itself.

A tool life of about nine months under production conditions is claimed. It is also mentioned that the new unit is now being used in about a dozen potteries.

It might be recalled that some months ago we gave prominence to this idea of an automatic making machine which had been developed by Service Engineers Ltd., of Stoke-on-Trent. We picture the illustration used then, together with the demonstration of the American machine.

PLANT FOR SALE

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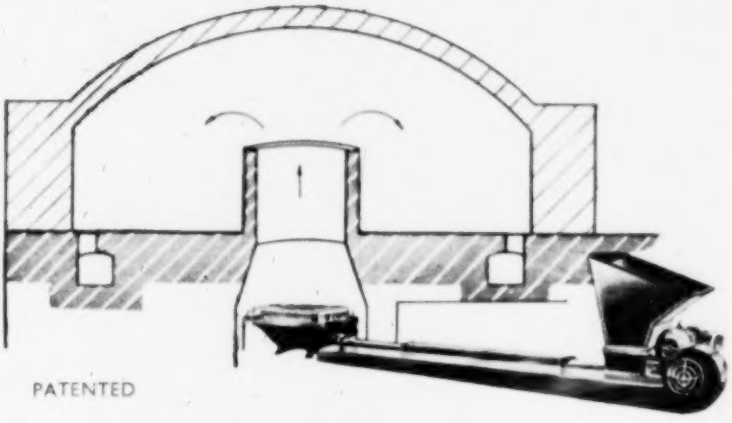

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